MYCOLOGIA

VOL. VII MARCH, 1915 NO. 2

WILLIAM WIRT CALKINS, AMATEUR MYCOLOGIST

BRUCE FINK

(WITH PLATE 154)

Mr. William Wirt Calkins was born May 29, 1842, and died July 9, 1914. Illinois was his native state and remained his residence throughout his life. He prepared for Yale, and began teaching as a ward principal in Ottawa, Illinois, in 1862. However, he soon resigned, enlisted, and served in the Civil War until its close. At the close of the war, he entered business life and studied law. His life was devoted mainly to law and to literary work.

Mr. Calkins was a lover of the natural sciences from boyhood. His earliest interest was in the study of rocks and fossils, but, unfortunately, his large collection was destroyed in the Chicago fire of 1871. After this, he studied conchology, and a number of papers on this subject appeared. About the same time, he began the study of seed-plants, and his collection of about 4000 species is now in the herbarium of the University of Notre Dame. He began the study of fungi about 1885, and papers on lichens and other fungi began to appear at once. Though he collected and distributed large numbers of fungi of various kinds collected in the South and mainly in Florida, it is apparent both from his publications and from conversations and correspondence with him that he soon gave up all other fungi for the lichens, which remained his main botanical interest until the time of his death.

[MYCOLOGIA for January, 1915 (7: 1–55), was issued February 3, 1915.]

His collection of mosses and lichens still remains in the possession of Mrs. Calkins. This collection contains 25 or 30 new species of lichens collected by Mr. Calkins and named mostly by William Nylander. Many of his other fungi were distributed by Ellis and Everhart.

Mr. Calkins was an amateur scientist, who was possessed of a genuine love of nature. Conditions of life prevented his entering the ranks of professional naturalists, but he never lost his relish for the study of natural science. He will be remembered by botanists as a keen-eyed collector of plants, who has by his field work materially added to our knowledge of various kinds of fungi. Some of his specimens will always remain in various American herbaria.

It will be of interest to botanists to know that Mr. Calkins was a prolific writer from early manhood. His first papers, in 1860, were on geology, and the whole number of papers and books to the time of his death was about 150. These writings covered titles on geology, conchology and other zoological subjects, war correspondence, various historical papers, and other miscellaneous topics. His history of the 104th Illinois regiment is a work of 518 pages, and there are one or two smaller historical books. His largest scientific paper seems to have been "The Lichen Flora of Cook County, Illinois"—a work of 50 pages with brief diagnoses of 125 lichens. There is added below a nearly complete bibliography of his botanical papers. Two papers on "The Flora about Berwyn, Illinois" published in "The Berwyn Current," in 1907, eight or nine botanical papers in "the Ottawa (Ill.) Republican," from 1880 to 1892, and three papers in the first volume of "The Valley Naturalist," some of which contain botanical material, have not been seen and therefore are not listed. The available titles are as follows:

1. **Calkins, W. W.** Rambles of a Naturalist in Southern Florida. Cinn. Quart. Journ. Sci. **2**: 161–164. 1875. Mainly on the fauna with a few notes on seed-plants and marine algae. Another paper under a different title was published in the same volume, but is devoted wholly to the fauna.

2. **Calkins, W. W.** Notes on the winter Flora of Florida. Bot. Gaz. **2**: 128–129. 1877.

3. **Calkins, W. W.** Tillandsias under cultivation. Bot. Gaz. **4**: 209–210. 1879.

4. **Calkins, W. W.** January flora of the Indian River country, Florida. Bot. Gaz. 4: 242. 1879.

5. **Calkins, W. W.** Winter herborizations on Indian River, Florida. Bot. Gaz. 5: 57–58. 1880.

6. **Calkins, W. W.** Botanical observations in Florida. Valley Natualist 2: 20–21 and 35–36. 1880. Notes on a considerable number of seed-plants.

7. **Calkins, W. W.** *Epidendrum cochleatum* L. Bot. Gaz. 7: 144. 1882.

8. **Calkins, W. W.** The W. W. Calkins collection of Florida woods. 1–10. Chicago, 1883.

9. **Calkins, W. W.** Notes on some little known Florida trees. Am. Journ. Forestry 1: 386–389. 1883.

10. **Calkins, W. W.** Notes on Florida lichens. Bot. Gaz. 10: 369–370. 1885. A note stating that he found 80 species.

11. **Calkins, W. W.** Catalogue of lichens collected in Florida in 1885, with notes. Journ. Mycol. 2: 112–114. 1886. A list of 73 species determined by Henry Willey.

12. **Calkins, W. W.** *Polyporus officinalis.* Journ. Mycol. 2: 107. 1886.

13. **Calkins, W. W.** Notes on Florida fungi.—No. 1. Journ. Mycol. 2: 6–7. 1886.

14. **Calkins, W. W.** Notes on Florida fungi.—No. 2. Journ. Mycol. 2: 23. 1886. This paper and number one of the series deals with higher basidiomycetes mainly.

15. **Calkins, W. W.** The leaf fungi of Florida.—No. 3. Journ. Mycol. 2: 42. 1886.

16. **Calkins, W. W.** Cryptogamic botany of a Florida log.—Paper 4. Journ. Mycol. 2: 53–54. 1886. Notes on 15 lichens and other fungi found on a giant log in a hummock.

17. **Calkins, W. W.** Notes on Florida fungi.—No. 5. Journ. Mycol. 2: 70. 1886. Notes on a few higher basidiomycetes.

18. **Calkins, W. W.** Notes on Florida fungi.—No. 6. Journ. Mycol. 2: 80–81. 1886. Remarks on the small number of basidiomycetes found in pine woods.

19. **Calkins, W. W.** Notes on Florida fungi.—No. 7. Journ. Mycol. 2: 89–91. 1886. A list of 35 polypores collected near Jacksonville and named by J. B. Ellis.

20. **Calkins, W. W.** Notes on Florida fungi.—No. 8. Journ. Mycol. 2: 104–106. 1886. A continuation of the last, giving numbers 36 to 78 of the higher basidiomycetes collected near Jacksonville and determined by Mr. Ellis.

21. **Calkins, W. W.** Notes on Florida fungi.—No. 9. Journ. Mycol. 2: 126–128. 1886. A continuation of the Florida fungi, listing numbers 79 to 136,—basidiomycetes and ascomycetes.

22. **Calkins, W. W.** Notes on Florida fungi.—No. 10. Journ. Mycol. 3: 7. 1887. A list of various fungi, continuing the list to number 163.

23. **Calkins, W. W.** Notes on Florida fungi.—No. 11. Journ. Mycol. 3: 33–34. 1887. A continuation of the list of fungi to number 183. This paper includes only polypores.

24. **Calkins, W. W.** Notes on Florida fungi.—No. 12. Journ. Mycol. 3: 46. 1887. Numbers 184 to 216, mostly higher basidiomycetes with a few ascomycetes.

25. **Calkins, W. W.** Notes on Florida fungi.—No. 13. Journ. Mycol. 3: 58–59. 1887. Numbers 217 to 250, various fungi.

26. **Calkins, W. W.** Notes on Florida fungi.—No. 14. Journ. Mycol. 3: 70. 1887. Numbers 251 to 280, various fungi.

27. **Calkins, W. W.** Notes on Florda fungi.—No. 15. Journ. Mycol. 3: 82. 1887. Numbers 281 to 300, various fungi.

28. **Calkins, W. W.** Notes on new Florida lichens. Bull. Torr. Bot. Club 16: 330. 1889. A list of six species named by Dr. W. Nylander.

29. **Calkins, W. W.** Notes on rare East Tennessee lichens. Am. Nat. 24: 1078–1079. 1890. Thirty-three species listed with notes.

30. **Calkins, W. W.** An edible lichen not heretofore noted as such. Bot. Gaz. 17: 418. 1892. Discusses *Endocarpon miniatum* (L.).

31. **Calkins, W. W.** Remarks on North American lichenology,—preliminary. Science 20: 120. 1892.

32. **Calkins, W. W.** Remarks on American lichenology.—II. Science 20: 205–206. 1892.

33. **Calkins, W. W.** Remarks on American lichenology.—III. Science 21: 77–78. 1893. Notes on some 20 lichens collected near Jacksonville, Florida.

34. **Calkins, W. W.** The lichen flora of Chicago and vicinity. Chicago Acad. Sci. 1: 1–50. 1896. Contains short diagnoses of 125 lichens. *Verrucaria prospersella* is described as new.

35. **Calkins, W. W.** Mosses of Cook County, Illinois. Bryologist 13: 107–111. 1910. A list of 51 species with notes on habitat and locality.

36. **Eckfeldt, J. W. and Calkins, W. W.** The lichen flora of Florida. Journ. Mycol. 3: 121–126 and 133–137. 1887. A list of 330 lichens with notes. Nine species were listed as new, *nomina nuda*. These have been described since.

37. **Huett, J. W.** Natural history of La Salle County, Illinois. Part 2. Geology and Zoology. 1–174. *pl. 1–3.* Ottawa, Illinois, Fair Dealer Print, 1898. Pages 120 to 149 contain "The Lichen-flora of La Salle County" by Calkins. There are short descriptions of 131 lichens.

38. **Jordan, D. S.** The fur seal and Fur-Seal Islands. Part 3. I-XI. 1–629. *pl. 1–94.* Many figures partly unnumbered. Washington, D. C., Government printing office, 1899. On page 583 is a list of nine lichens determined by Calkins.

MIAMI UNIVERSITY,
OXFORD, OHIO.

WILLIAM WIRT CALKINS

CULTURES OF UREDINEAE IN 1912, 1913 AND 1914.[1]

J. C. Arthur

The present article is the thirteenth of a series of reports[2] by the writer upon the culture of plant rusts, beginning in 1899 and completing sixteen consecutive years. The work for the three years covered by the present report has been done under the auspices of the Indiana Experiment Station, as a part of a research project supported by the Adams Fund.

The heaviest part of the work each year falls in April and May, and during this time the regular staff of the botanical department of the Experiment Station is supplemented in order to take care of the largely increased routine part of the work. In 1912 the assistant for the culture work was Mr. L. O. Overholts, a senior student of Miami University, Ohio, recommended by Dr. Bruce Fink; in 1913 Mr. Ezra Levin, junior student with credits at the Agricultural College of Michigan, recommended by Dr. Ernst A. Bessey, was in charge; and in 1914 Mr. Carl B. Gibson, senior student of Wabash College, Indiana, recommended by Prof. H. W. Anderson, did the work.

A large number of correspondents have assisted as in previous years by sending culture material, often by supplying information from field observations, and sometimes by making special trips to secure additional material or search for cultural clues. To all such persons, and especially to those who have been to trouble and expense in response to the wishes of the writer for local aid, the most hearty thanks are accorded. Without the assistance of observers in the field, the work of studying the life histories of the rusts extending over the vast territory of North

[1] Presented before the Botanical Society of America at the Philadelphia meeting, December 29, 1914.

[2] See Bot. Gaz. **29**: 268–276; **35**: 10–23; Jour. Myc. **8**: 51–56; **10**: 8–21; **11**: 50–67; **12**: 11–27; **13**: 189–205; **14**: 7–26; Mycol. **1**: 225–256; **2**: 213–240; **4**: 7–33, 49–65.

America, many species of which are local, would proceed much more slowly.

An important aid in bringing together information regarding relationship of the rusts, and especially regarding obscure species, and in securing cultural material of critical forms, has been the excursions, often of considerable length, undertaken by the writer and members of his staff.

Early in April, 1912, Dr. F. D. Kern and the writer paid a visit to Auburn, Ala., where in company with Prof. F. E. Lloyd, field conditions of *Peridermium fusiforme* and *Puccinia angustatoides,* the latter on *Rynchospora,* were studied.

In the latter part of May, 1912, the writer and Mr. F. J. Pipal spent two days in LaGrange county on the northern border of Indiana, in a vain search for the alternate host of the *Carex* rust, *Puccinia vulpinoidis.*

An excursion on the last of May, 1912, was made to the coast of Maine by Mr. C. R. Orton and the writer. The localities visited were on the Isle au Haut, where the writer had found a number of imperfectly known rusts during several vacational sojourns. A station for the *Puccinia* on *Carex maritima* on Deer Isle was also visited. All previous observations had been made between July and October, and this long journey of over a thousand miles was for the purpose of seeking out probable aecial hosts under spring conditions. Upon the return journey, Mr. Orton stopped in Vermont and secured cultural material, especially forms on *Carex.*

Between June 17 and 20, 1912, the writer made observations in company with Dr. J. J. Davis about Madison, Wis., and northward.

From the middle of July to the middle of August, 1912, Dr. Kern and the writer traveled over a thousand miles through the high mountains of southern Colorado, going west through the middle of the state, and returning along the southern border. A week was spent in the wonderful valley at Ouray and some days at Pagosa Springs. Very helpful information was gleaned regarding grass rusts, and particularly of the leaf and stem forms which the older mycologists listed as *Puccinia graminis* and *P. rubigo-vera.*

Three weeks of August, 1913, were spent in company with Mr. H. C. Travelbee, in northern Michigan in the vicinity of Leland. Here very abundant field confirmation was obtained of the correctness of the 1913 spring culture work in associating *Puccinia vulpinoidis* with aecia on *Solidago,* and material was secured for repeating the work.

Two days were profitably given in November, 1913, accompanied by Dr. F. D. Fromme, to an exploration of the Kankakee marshes in northern Indiana, and as much time in December following, accompanied by Mr. C. A. Ludwig, to a reconnoissance about French Lick in southern Indiana.

During February and the early part of March, 1914, an extended trip by Dr. Fromme and the writer was made through the Southwest. Field work began at Denison, on the northern border of Texas. At Denton the localities made interesting to uredinologists by the extended field work of Mr. W. H. Long were visited. Stops on the way southward to Austin, and a divergence to Houston and Galveston, gave interesting results. Observations in the arid region were made principally at San Antonio and El Paso, Texas, the region about the Agricultural College, N. Mex., and at Douglas and Tucson, Ariz. At Tucson through the kindness and material assistance of Dr. D. T. MacDougal and his corps of investigators at the Desert Botanical Laboratory, the rust flora of the vicinity was examined, and a very important culture on *Brodiaea* was carried to completion.

The dominant ideas actuating the above mentioned geographical explorations are not so much those of the ordinary collector, to find new species, but rather those of the student, to secure additional knowledge of species already named but imperfectly known, and to gather facts bearing upon relationships.

To indicate the extent of the labor involved in securing the results recorded in this paper the following statistics are given. During the three seasons covered by this report, 380 collections with resting spores, and 68 with active spores were available, but scarcely one third of those with resting spores could be made to germinate. To test the germinating condition of the spores over 2500 drop cultures were made. Altogether 650 sowings were undertaken upon growing hosts and 84 infections obtained.

NEGATIVE RESULTS.—It has been customary in these reports to record failures to ascertain the alternate host, when sowings were made with spores known to be capable of germination and made upon plants that were in proper condition for infection. As the work progresses, and fewer species are left to be connected with alternate hosts, the need of such records diminishes, especially as more and more dependence is placed upon field observations for the clues to relationship. A few trials during the last three years with negative results appear to be sufficiently significant to be worthy of record at this time.

1. PUCCINIA MCCLATCHIEANA Diet. & Holw.—A collection of this species on *Scirpus microcarpus* (*S. rubrotinctus*), from Vaughns, Washington Co., N. Y., sent by Mr. Stewart H. Burnham, was used for sowings made April 1, 1914, on *Chelone glabra, Hydrophyllum virginicum, H. Fendleri, Actaea alba, Dirca palustris,* and *Iris versicolor,* all without infection.

This species has been confused with *Puccinia angustata* Peck. The name was first applied to a Californian collection thought to be on *Scirpus sylvaticus,* but now determined as *S. microcarpus.* It is a common species along the Pacific coast on the last named host, known in one instance as far into the mountains as Belgrade near Bozeman, in southwestern Montana. It also occurs along the Atlantic coast on the same host (usually called *S. rubrotinctus*), being known from Nova Scotia to Delaware, and inland as far as Albany, N. Y. It was a collection of this species and host that was cited by Peck in establishing his *Puccinia angustata,* as on "*Scirpus sylvaticum,*" from West Albany, N. Y. No clues to the identity of the alternate host have yet been secured.

2. PUCCINIA CRYPTANDRI Ellis & Barth.—A good teliosporic collection of this rust on *Sporobolus cryptandrus* was obtained by Dr. Fromme and the writer February 20, 1914, at Mesilla Park, N. Mex., and sown March 20 on *Sphaeralcea lobata, S. incana,* and *Callirhoe digitata.* Eight days later it was sown on other plants of *S. incana* and *C. digitata,* and on *Hibiscus militaris.* Again on March 9, it was sown on *Hydrophyllum Fendleri, Phacelia tanacetifolia, Thalictrum Fendleri,* and *Abronia umbellata.*

A collection similar to the last was obtained on the preceding day, but thought at the time to be *Puccinia tosta,* which was

sown April 17 on *Lithospermum officinale, Aesculus glabra, Eleagnus argentea, Lepargyraea canadensis,* and *Doellingeria umbellata.* It was sown again March 20 on *Sphaeralcea lobata, Callirhoe digitata* and *C. involucrata.* No infection was secured.

This is the first attempted culture of this species with teliospores, although once grown from amphispores.[3] Most collections show only the amphisporic stage of the rust. No clue to the alternate host has yet been obtained.

3. PUCCINIA EMACULATA Schw.—This exceedingly common rust on *Panicum capillare* has been used in previous years for sowings on 26 different species of hosts with no infection.[4] A careful morphological study shows that the species in its uredinial and telial conditions is very like *Puccinia Pammelii* Arth. (*P. Panici* Diet.), occurring commonly on *Panicum virgatum,* whose aecia have been grown upon *Euphorbia corollata.* Since this fact was ascertained, attempts have been made to grow *P. emaculata* upon *Euphorbia corollata.* Telial material from the vicinity of Lafayette, Ind., was sown accordingly on April 28, 1913, March 24, 31, and April 6, 1914. Material collected by Dr. Fromme at Lakehurst, N. J., was sown May 8, 1914, on both *E. corollata* and *E. cyparissias.* A collection from Lafayette was also sown March 31, 1914, on *Chelone glabra,* and *Dirca palustris,* which had not previously been tried. All attempts were equally fruitless. It is hoped that some time a fortunate field observation may lead to the solution of the problem.

4. UROMYCES RHYNCOSPORAE ELLIS.—No satisfactory field clues to the alternate host of this species have yet been obtained. Morphological study has led to the suggestion, improbable as it may seem at first, that it can belong to the very common *Carex-Aster-Solidago* complex. To test this suggestion, material obtained by Dr. Kern and the writer at Auburn, Ala., was sown April 22, 1912, on *Aster paniculatus, Solidago canadensis,* and *Helianthus angustifolius.* Another set of sowings was made on May 8 following upon other plants of the same three hosts, and on *Ruellia strepens,* and *Apocynum cannabinum.* No infection

[3] Jour. Myc. **14**: 20. 1908.

[4] Bot. Gaz. **35**: 12. 1903; Jour. Myc. **8**: 52. 1902; **10**: 10. 1904; **12**: 12. 1906; **13**: 192. 1907; **14**: 11. 1908; and Mycol. **1**: 230. 1909.

was obtained. Cultures were attempted on *Menyanthes* and *Decodon* in 1907, also without results.[5]

5. UROMYCES SPOROBOLI E. & E.—While on a visit to Mr. E. Bartholomew at Stockton, Kans., in August, 1911, the spot was pointed out where this rust on *Sporobolus longifolius* had been observed for several seasons following close upon a luxuriant development of an *Aecidium* on *Allium reticulatum*, as if the two might have genetic connection. Excellent material for testing the assumption was supplied the following spring, and a sowing was made April 29, 1912, upon *Allium reticulatum*, and also on *Malvastrum coccineum, Cassia chamaecrista, Baptisia bracteata, Apios tuberosa, Corydalis aurea, Zanthoxylum americanum, Physalis pubescens, Asclepias verticillata, Vagnera stellata*, and *Erigeron annuus*, all known to have aecia of uncertain connection, but without infection.[6]

SUCCESSFUL CULTURES SUPPLEMENTING PREVIOUS WORK.—The facts derived from growing the following species of rusts supplement those obtained from previous cultures in this series or from cultures recorded by other American or European investigators. In some cases the additional information recorded is of as great value as if it were entered under the next heading of cultures not before reported. For instance, the hitherto accredited species, *Puccinia vulpinoidea, P. Dulichii*, and *P. tosta*, are reduced to synonymy, and in so far simplify the naming of collections, beside permitting of a clearer conception of the variation of specific characters. A few cultures were made which are not reported, as they add no new facts to those already established.

CULTURES OF 1912

1. PUCCINIA GROSSULARIAE (Schum.) Lagerh.—The following successful cultures were made, all being sown on *Ribes Cynosbati*.

From *Carex pubescens*, Lafayette, Ind., sown April 20, showing pycnia April 29, and aecia May 9.

[5] Jour. Myc. 14: 12. 1908.

[6] For previous attempts see Bot. Gaz. 35: 11. 1903; and Mycol. 1: 13. 1912.

From *Carex crinita*, St. Anne de Bellevue, Quebec, sown May 8, showing pycnia May 16, and aecia May 24.

From *Carex arctata*, St. Anne de Bellevue, Quebec, sown May 8, showing pycnia May 22, and aecia May 27.

From *Carex tenuis*, St. Anne de Bellevue, Quebec, sown May 13, showing pycnia May 22, and aecia May 27.

In the report of cultures for 1910[7] the status of the name *P. albiperidia*, as representing a distinct species of *Carex-Ribes* rust, was discussed, but left somewhat unsettled. It was, however, thought to belong to a form possessing urediniospores with one basal pore, while the more common form on the same hosts, *P. Grossulariae*, has urediniospores with three equatorial pores. Subsequently Mr. C. R. Orton went over the material involved, including the type of *P. albiperidia*, and concluded[8] that this name should be a synonym of *P. Grossulariae*, and that the form having urediniospores with one basal pore is entitled to be considered a distinct species to which he gave the name *P. uniporula*, a species correlated with *Uromyces uniporulus* Kern, the aecia of both species being unknown.

To gather further information I have had single sori removed from the type collections of both species of *Puccinia* involved, and have had the spores of each sorus separately counted by using a mechanical stage. The results are given in the following table. The type of *P. albiperidia* is on wintered-over leaves, having been gathered April 30, 1901, at Lafayette, Ind., and provides few urediniospores, while that of *P. uniporula* was gathered August 20, 1910, at London, Ontario, and gives a fair number of urediniospores. Both types are on *Carex pubescens*. As usual when urediniospores are taken from mature telial sori, many of the spores are not in condition to show the pores. When the pores could not be ascertained with fair certainty, even after using lactic acid or chloral hydrate with iodine, the spores have been classed as uncertain. It was also necessary to take the number of cells in the teliospore into account, as *Carex pubescens* also bears *Uromyces uniporulus*, chiefly distinguishable by the teliospores.

[7] Mycol. 4: 13–15. 1912.

[8] Mycol. 4: 200, 201. 1912.

SPORES FROM TYPE COLLECTIONS OF *Puccinia albiperidia* and *P. uniporula*: EACH SORUS GIVEN SEPARATELY.

	Number of Sorus	Teliospores with 1-cell (*Uromyces*)	Teliospores with 2-cells (*Puccinia*)	Urediniospores with One Basal Pore	Urediniospores with Three Equatorial Pores	Urediniospores with Pores Uncertain
Puc. albiperidia	1	0	Not counted	0	0	0
	2	0	231	0	0	0
	3	0	317	0	0	0
	4	0	363	3	0	1
	5	0	886	4	0	2
	6	1	327	0	1?	4
	7	29	1325	0	0	3
	8	314	3	0	1?	0
	9	422	1	0	0	0
	10	697	2	0	0	1
	11	Not counted	0	0	0	0
Puc. uniporula	12	0	142	17	2	5
	13	3	853	4	1	5
	14	3	871	3	0	1
	15	4	1455	5	0	1
	16	5	19	12	1	7

Taking first the two columns of teliospores in the above table, it may be assumed that when a few only of either one- or two-celled teliospores occur in a sorus they are to be considered as incidental, possibly mesosporic. We may exclude from our present consideration four sori (8 to 11 incl.) from the type of *P. albiperidia*, as belonging to another species, *Uromyces uniporulus*, intermixed on the same leaf blades.

Of the remaining seven sori taken from the type of *P. albiperidia*, two of them (numbers 4 and 5) show a few urediniospores with one basal pore, and one sorus (number 6) shows one urediniospore with apparently three equatorial pores, while all others give no urediniospores whose pores could be made out with certainty.

Of the five sori (12 to 16 incl.) taken from the type of *P. uniporula* all show a number of urediniospores with one basal pore, and in addition three of the sori (numbers 12, 13, and 16) show urediniospores with three equatorial pores, as well as a number of spores whose pores could not be located. It is curious to note that in this type material of *P. uniporula* about one tenth of the urediniospores possess equatorial pores, and that these spores are intermixed in the same sori with the one-pored spores.

So far as the morphological evidence goes, there appears to be

no absolute difference between the types of *P. albiperidia* and *P. uniporula.* But *P. albiperidia* has been cultured on *Ribes,* producing aecia that can not be distinguished from those *Carex* rusts which show urediniospores with equatorial pores only. Whether aeciospores grown from *P. albiperidia* material would reproduce urediniospores, when sown back on a suitable *Carex,* with only three-pored or only one-pored urediniospores, or with sori containing a mixture of the two, is yet to be demonstrated. In the meantime, it seems best to use the name *P. albiperidia* as representing a form with aecia on *Ribes,* and synonymous with *P. Grossulariae,* while *P. uniporula* can be retained for such collections as show a preponderence of one-pored urediniospores. It is interesting to note in this connection that in Europe no *Carex* rust has yet been found agreeing with the uniporulate forms here discussed.

The essential specific unity of all *Carex-Ribes* rusts in both America and Europe was the conclusion reached by Dr. H. Klebahn in 1907. Dr. Klebahn's extended cultural work on this group of rusts began in 1892, and resulted in the separation of five species. In 1904 and 1906 he studied the behavior of American material grown from teliospores transmitted by the writer. Taking into account both European and American material, he came to the conclusion[9] that the six described species of *Carex-Ribes* rusts were biological forms of one collective species, for which he suggested the name, *Puccinia Ribesii-Caricis.* This conclusion is upheld by the above study, although an earlier name is preferred for the species.

2. PUCCINIA CARICIS-ASTERIS Arth. (*P. Caricis-Solidaginis* Arth.)—Five successful cultures of this rust were secured. They are as follows:

Teliospores from *Carex* sp., London, Ontario, sown April 10 on *Aster* sp., showing pycnia April 16, and aecia April 27.

Teliospores from *Carex* sp., Lafayette, Ind., sown April 11 on *Aster* sp., showing pycnia April 23, and aecia April 29.

Teliospores from *Carex retrorsa,* St. Anne de Bellevue, Quebec, sown May 14 on *Aster paniculatus,* showing pycnia May 22, and aecia May 27.

Teliospores from *Carex scoparia,* St. Anne de Bellevue, Quebec, sown May 13 on *Aster paniculatus,* showing pycnia May 22, and aecia

[9] Klebahn, Zeits. Pflanzenkr. 3: 134. 1907.

May 27; also sown same date on *Euthamia graminifolia*, showing pycnia May 22, at aecia June 4.

The significant thing about these cultures is that the material from *Carex scoparia*, which was sent by Mr. W. P. Fraser, grew on both *Aster* and *Euthamia*. The rust on this species of *Carex*, as represented in the herbarium, was for a long time considered sufficiently diverse morphologically to constitute a distinct species. Two years ago material on *Carex scoparia* from Maine was cultured on *Euthamia*,[10] but did not grow on *Aster paniculatus* or *Solidago canadensis*. This year sowings were made on the three hosts named and results obtained on two of them. It was pointed out in the discussion of the results two years ago that the *Aster-Solidago-Erigeron* group of *Carex* rusts probably constitutes a single species with a number of more or less defined races. The same view has been expressed elsewhere.[11] Numerous confirmatory facts of diverse nature have been accumulating, until it seems advisable to adjust the nomenclature to accord with present knowledge.

This species is one of the most common forms of rust in North America. It evidently is less abundant in South America and in the eastern hemisphere. The morphological study of similar European forms, rated as species, discloses some that undoubtedly are to be classed in the same category with the American group. Without taking space to record the evidence, the conclusion has been reached that the most available name for the American and European constituents of the species here represented, but possibly not the oldest one, is *Puccinia extensicola* Plowr. This name was founded on telial material from *Carex extensa*, obtained at Norfolk, England, and cultured on *Aster Tripoli*, and is in every way comparable with the *Carex-Aster* forms of America.[12]

3. PUCCINIA ANGUSTATA Peck.—Teliospores on *Scirpus atrovirens*, collected at Lafayette, Ind., by L. O. Overholts, were sown

[10] Mycol. 4: 15. 1912.

[11] Arthur, The physiologic aspect of the species question. Amer. Nat. 42: 246. 1908.

[12] For previous American cultures of this specific group, see Bot. Gaz. 35: 15, 21. 1903: Jour. Myc. 8: 53, 54. 1902; 11: 58. 1905: 12: 15. 1906; 14: 13. 1908; Mycol. 1: 233. 1909; 2: 224. 1910; and 4: 15, 16. 1912.

May 9 on *Lycopus americanus,* giving rise to pycnia May 16, and aecia May 24. Another collection believed to be the same rust and on the same host, collected at London, Ontario, by J. Dearness, was sown May 13 on *L. Americanus,* giving rise to pycnia May 20, and aecia May 27. Corresponding cultures have been made many times before.[13] The rust is very common throughout the eastern United States, especially northward, but has not been seen in the Rocky mountain region or on the Pacific coast. Professor Peck based the name, *Puccinia angustata,* which was published in the Bulletin of the Buffalo Society of Natural History, volume 1, page 67, July, 1873, upon material from "leaves of *Scirpus sylvaticum* and *S. Eriophorum;* West Albany and Watkins, September." Upon examination of type material, it transpires that the collection on "*S. sylvaticum*" was made at Watkins, N. Y., and that on *S. Eriophorum* at West Albany, N. Y., and furthermore, that of the two hosts cited only *S. Eriophorum,* collected at Watkins, N. Y., although the second one mentioned, bears teliospores that correspond to the description. The other collection on "*S. sylvaticum,*" found to be in reality *S. microcarpus* (*S. rubrotinctus*), bears a distinctly different form of teliospore, and must be considered to belong to some other species than *P. angustata.* The type of *P. angustata* Peck is, therefore, the collection in the herbarium of the New York State Museum, at Albany, N. Y., collected in September [1871?], at Watkins, N. Y., on *Scirpus Eriophorum,* by Prof. C. H. Peck. Thanks are due to Prof. Peck for the loan of the type material and for much assistance in ascertaining numerous facts connected therewith.

4. PUCCINIA ELLISIANA Thüm.—A collection on *Andropogon* sp., made by Dr. J. F. Brenckle, at Kulm, N. D., was used to sow, April 9, on *Viola cucullata, V. Nuttallii, V. primulaefolia, Laciniaria punctata* and *Lithospermum angustifolium,* with infection only on the two first named species of *Viola.* In both cases pycnia began to show in abundance May 8, and aecia May 12.

A number of vain attempts have been made in previous

[13] For previous cultures see Bot. Gaz. **29**: 273. 1900; Jour. Myc. **8**: 53. 1902; **11**: 58. 1905; **13**: 196. 1907; **14**: 14. 1908; Mycol. **1**: 234. 1909; **4**: 17 and 54. 1912.

years[14] to culture this rust, thirty-five species of hosts having been used other than those used this year. Only once was a plant of *Viola* used, *V. striata,* a caulescent species on which such aecia have not yet been found, and are not very likely to occur.

The successful cultures were inspired by field observations by Dr. Brenckle, who sent us material with which to test his prediction. In addition to Dr. Brenckle's opinion there was also at hand the opinion of Mr. C. R. Orton, at that time working on the rusts in my laboratory, which was drawn from a study of correlation between this species and *Uromyces pedatatus,* in a paper read December 28, 1911, but not published until later,[15] the latter species having its aecia on acaulescent violets. Since that time Mr. W. H. Long has published[16] extended studies, both cultural and morphological, with important bearings which can not be taken into consideration in this connection.

5. PUCCINIA STIPAE Arth.—Two collections with teliospores on *Stipa comata,* gathered by Mr. E. Bethel, from different spots at Boulder, Colo., were used for cultures. One was sown May 15 on *Senecio lugens, S. spartioides,*[17] *Chrysopsis villosus, Grindelia squarrosa, Gutierrezia Sarothrae,* and *Solidago mollis,* all considered probable hosts for the aecia. Infection occurred only on *Gutierrezia Sarothrae,* showing pycnia May 22, and aecia May 27, both in abundance.

The other collection was sown May 17 on the same set of hosts with infection only on *Senecio spartioides,* showing numerous pycnia May 23, and aecia June 1.

This species has previously been cultured[18] on *Aster multiflorus, A. ericoides, A. Novae-Angliae, Solidago canadensis, Grindelia squarrosa,* and *Senecio lugens.* The present study adds two

[14] See Jour. Myc. 14: 10. 1908; Mycol. 1: 231. 1909; 2: 220. 1910; and 4: 9. 1912.

[15] Mycol. 4: 199, 200. *pl. 70, figs. 5 and 6.* 1912.

[16] Notes on three species of rusts on *Andropogon,* Phytopath. 2: 164–171. August, 1912; and Influence of the host on the morphological characters of *Puccinia Ellisiana* and *Puccinia Andropogonis,* Jour. Agric. Research 2: 303–319. July, 1914.

[17] The same host that was erroneously called *S. Douglasii* in report for 1910. Mycol. 4: 9, 11. 1912.

[18] See Jour. Myc. 11: 63. 1905; and Mycol. 4: 19. 1912.

aecial hosts to the list previously known, and further strengthens the view that the species consists of a number of loosely defined races.

6. PUCCINIA AGROPYRI E. & E.—Three collections on *Elymus canadensis* from two widely separated and very different habitats were successfully cultured. One collection made by Mr. E. Bethel at Boulder, Colo., from plants on which he had previously placed leaves of *Clematis ligusticifolia* covered with aecia, brought from thirty miles distant, was sown April 27, on *Clematis ligusticifolia, C. Douglasii, Anemone cylindrica, Delphinium Geyeri,* and *Thalictrum Fendleri,* all believed to be probable hosts of this rust, and on *Phacelia heterophylla, Hydrophyllum capitatum, H. Fendleri,* and *Onosmodium occidentale,* which have been suspected from field observations to belong to the list of hosts. Infection only occurred on *Clematis ligusticifolia,* showing pycnia May 8, and aecia May 20.

Another collection by Mr. Bethel from plants growing with aecia-bearing *Clematis lingusticifolia,* at Boulder, Colo., was sown May 14, on the same nine species of hosts, with infection only on *Clematis ligusticifolia,* showing pycnia May 21, and aecia May 29.

The third collection by Dr. Brenckle from Kulm, N. Dak., was sown on *Clematis ligusticifolia, C. Douglasii, C. virginiana, Anemone cylindrica, Delphinium* sp. from Colorado, *Thalictrum Fendleri, T. alpinum, Aquilegia caerulea,* and *A. flavescens,* all belonging to a quite possible group of hosts, and on the outlying hosts, *Phacelia heterophylla, Hydrophyllum Fendleri, Onosmodium occidentale,* and *Elaeagnus argentea.* Infection was obtained only on *Anemone cylindrica,* showing a few pycnia May 20, but without maturing aecia.

Another collection of the same rust on *Agropyron Smithii* (host determined by Prof. A. S. Hitchcock), collected by the writer at Pueblo, Colo., was sown April 29, on *Clematis ligusticifolia, C. Douglasii, Anemone cylindrica, Delphinium* sp. from Colorado, *Thalictrum Fendleri, Hydrophyllum capitatum, H. Fendleri,* and *Onosmodium occidentale,* with infection only on the first named. The pycnia began to show May 8 and aecia May 17.

Cultures from *Elymus* on *Clematis ligusticifolia* are now reported for the first time. It has seemed quite probable from field observations that the aecia occurring on this host in great abundance throughout the Rocky Mountains were probably connected with telia on other hosts than *Agropyron,* where they have usually been assigned in this country and Europe, but this is the first direct proof by cultures. In 1904 a rust on *Bromus* from Iowa, Indiana, and Wisconsin, believed to be *Puccinia tomipara* Trel., was grown on *Clematis virginiana.* In a discussion of the results[19] it was considered that the aecia were the form known as *Aecid. Clematitis* Schw., and distinct from the form in the Rocky Mountains, going to telia on *Agropyron.* The latter form, called *Aecid. Clematidis* DC., was grown in 1907[20] from Rocky Mountain material on *Agropyron,* but on the eastern host *C. virginiana,* no plants of *C. ligusticifolia* being available at the time. This was considered a demonstration that the form known and cultured in Europe as *P. Agropyri* E. & E., on *Agropyron,* is identical with the western form, but distinct from the eastern *Bromus-Clematis* rust.

In 1908 a rust on *Bromus* from the Rocky Mountains was grown on *Thalictrum dioicum* with success. The same season a similar subepidermal rust on *Agropyron* from the western mountains was grown on *Aquilegia.* These two forms were considered to represent distinct species and were named respectively *Puccinia alternans* and *P. obliterata.*[21]

The first cultural study of this group of subepidermal rusts began in 1903 with a supposed culture of *Dirca aecia* on *Bromus,*[22] an error which was rectified in the report of cultures the year following. From that time to the present morphological studies, field observations, and careful cultures have multiplied until now there seems to be no further doubt that this group of subepidermal forms, passing under various names, represents only one species, but a species broken up into a number of races of considerable

[19] Jour. Myc. 11: 62–63. 1905; also 13: 197. 1907; and Mycol. 1: 236. 1909.

[20] Jour. Myc. 14: 15. 1908.

[21] Mycol. 1: 248–251. 1909; also 2: 225. 1910.

[22] Jour. Myc. 10: 19. 1904; also 11: 62. 1905.

fixity. The telia are on *Agropyron, Elymus,* and *Bromus* chiefly and the aecia on *Clematis, Thalictrum, Aquilegia, Anemone,* and probably other Ranunculaceous hosts, and possibly on some hosts of other families.

7. PUCCINIA MONOICA (Peck) Arth.—In the report of cultures for 1911[23] record was made of sowings of teliospores from *Trisetum subspicatum* made June 20 upon two plants of *Arabis* (grown from Colorado seed), one plant of which indicated infection by a pathological change into a glomerate mass of rosettes, somewhat paler than normal. In this condition the plant passed the winter. Early in spring it began to send up a half dozen or more shoots instead of the usual single shoot of normal plants. Pycnia first were seen March 23, 1912, scattered over the considerably drawn shoots. Before there was time for the aecia to mature the plant accidentally died.

Freshly gathered plants of an *Arabis* bearing aecia, obtained May 13 at Palmer Lake, Colo., were received from Mr. Bethel, and aeciospores from them sown May 18 on leaves of *Koeleria cristata* and *Trisetum subspicatum.* Infection occurred only on the *Koeleria,* uredinia first being noticed June 18, and telia June 24.

There is no present need of adding to the general discussion of this species given in the last report of cultures.[24] We have now grown the rust from both aeciospores and teliospores, and shown that it occurs on both *Trisetum* and *Koeleria,* with some indication of biological races.

8. UROMYCES PERIGYNIUS Halst.—A collection on *Carex intumescens,* made by Dr. Charles E. Fairman at Lyndonville, N. Y., was sown April 24, on *Aster paniculatus, Solidago canadensis, Erigeron annuus, Euthamia graminifolia,* and *Onagra biennis.* On May 7 pycnia began to show in great abundance on the *Aster,* followed on May 10 by aecia. On the *Solidago* a few pycnia appeared May 8, but no aecia developed, although the host plant was in good condition.

In former cultures[25] material on this host from Nova Scotia produced infection on *Aster,* but not on *Solidago.* Material on

[23] Mycol. 4: 60. 1912.
[24] Mycol. 4: 59. 1912.
[25] See Jour. Myc. 10: 15–17. 1904; Mycol. 4: 21, 22. 1912.

other hosts from Maine and Indiana produced strong infection on *Solidago*, and in one case a sparing infection also on *Aster*. In the first culture report on the species, the close resemblance between this species and the parallel form under *Puccinia*, that we are now calling *P. extensicola*, was pointed out, and in the second report the evidence of well defined biological races was adduced. Both of these points are further emphasized by the cultures here reported.

In this connection an error should be corrected in the report of cultures for 1910. Quite anomalous results[26] were obtained in that year by sowing material of *Puccinia quadriporula* Arth. from *Carex Goodenowii* from the type locality, upon *Aster paniculatus*. It was at that time pointed out that the resulting aecia were indistinguishable from those of *P. Caricis-Asteris* Arth. A careful re-examination of the culture records has revealed the fact that the sowing on April 26, 1910,[27] was immediately preceded by a very successful sowing of *Uromyces perigynius* on another plant of the same species of *Aster*. The inference is that the supposed result from the spores of *P. quadriporula* in reality came from stray spores of *U. perigynius* accidentally intermixed during the operation, and do not represent a culture of *P. quadriporula*.

Furthermore, a careful and extended morphological study of a number of collections of *P. quadriporula*, made in different years from the type locality and its vicinity, leave no doubt that the form should be placed under *P. Grossulariae*, a *Carex* rust having aecia on *Ribes*. The four-pored feature of the urediniospore, from which the name is derived, is found to be no more marked than in some other collections proven to be a part of that species.

9. UROMYCES JUNCI (Desm.) Tul.—It was stated in the report of cultures for 1910[28] that both Mr. Bethel and Dr. Brenckle held the opinion that this species in some one of its forms would be found to have aecia on *Ambrosia psilostachya*. Both gentlemen provided material for a test the present season, which verified their prediction, as the following record of cultures shows. The telial host in each instance was *Juncus balticus*.

[26] Mycol. 4: 28. 1912.
[27] Mycol. 4: 21. 1912.
[28] Mycol. 4: 23. 1912.

Telia from	Prediction for Aecia	Date of Sowing	Host for Culture	First Pycnia	First Aecia
North Dakota ...	*Carduus*	April 22	*Carduus Flodmanii*	May 7	May 12
			Ambrosia psilostachya	——	——
Colorado	*Ambrosia*	April 23	*Ambrosia psilostachya*	May 8	May 12
			Ambrosia trifida	May 8	——
			Carduus Flodmanii	——	——
Montana	.....	May 6	*Ambrosia psilostachya*	——	——
			Ambrosia trifida	——	——
			Carduus Flodmanii	May 16	May 21
North Dakota ...	*Ambrosia*	May 11	*Ambrosia psilostachya*	——	——
			Ambrosia artemisiaefolia	May 22	May 27
			Ambrosia trifida	——	——
			Carduus Flodmanii	May 20	May 27
			Silphium perfoliatum	——	——
			Laciniaria scariosa	——	——
			Xanthium canadense	——	——
North Dakota ...	*Ambrosia*	May 11	*Ambrosia psilostachya*	May 27	——
			Ambrosia trifida	——	——
			Xanthium canadense	——	——

The three collections sent by Dr. Brenckle from Kulm, N. Dak., bore out the prediction that he had based upon field observations. One of the collections grew upon both *Ambrosia* and *Carduus*, indicating that the races are not invariably fixed. The collection sent by Mr. Bethel from Boulder, Colo., also bore out the prediction which he had based on a field observation. No suggestions came with the collection sent by Mr. Vasku from Nihill, Mont. As stated in the North American Flora (**7**: 238. 1912), only *Carduus* has heretofore been proven by cultures in this country to be a host to this species, although both *Ambrosia* and *Arnica* have been considered to be hosts, a conclusion derived from morphological and field studies.[29]

10. UROMYCES ACUMINATUS Arth.—A collection made by Mr. Bethel at Boulder, Colo., on *Spartina Michauxiana*, showing the characteristic slender, acuminate teliospores to which this name has been applied, was suspected from field observations to belong to aecia found on *Collomia*. Sowings were made April 29 on *Collomia linearis*, *Steironema ciliatum* and *S. lanceolatum*. Infection resulted only on *Collomia*, showing a great abundance of pycnia May 8, and aecia May 12.

This culture adds one more host experimentally proven to belong to this species, although it had been associated with the spe-

[29] For previous cultures see Jour. Myc. **14**: 12. 1908; Mycol. **2**: 220. 1910; **4**: 22. 1912.

cies and with this particular race from morphological and field studies.[30]

11. GYMNOSPORANGIUM NELSONI Arth. (*G. durum* Kern).—Galls of this rust a half inch in diameter from *Juniperus scopulorum,* gathered by Mr. Bethel at Cimarron, Colo., were used for sowing May 25 on *Amelanchier canadensis* and *Crataegus punctatus.* Infection occurred only on *Amelanchier,* showing abundant pycnia June 4, but giving only a few aecia, first noticed July 17.[31]

12. GYMNOSPORANGIUM BETHELI Kern.—A collection of galls on small branches of *Juniperus scopulorum,* made by Mr. Bethel at Plainview, Colo., were used to sow, June 4, on *Crataegus Pringlei,* giving rise to pycnia June 14, and aecia July 17.[32]

13. GYMNOSPORANGIUM GRACILENS (Peck) Kern & Bethel.—A collection on *Juniperus utahensis,* made by Mr. Bethel at Glenwood Springs, Colo., was used for sowing on *Philadelphus coronarius,* giving an abundance of pycnia May 31, and aecia June 14. Another sowing was made at the same time on a horticultural form closely related to *P. coronarius,* imported from France, *P. Keteleerii,* which resulted in a luxuriant growth of pycnia May 30, and aecia June 22. These results confirm previous work.[33]

CULTURES OF 1913

14. PUCCINIA ALBIPERIDIA Arth.—A collection made by Mr. L. S. Orton at Walden, Vt., on a narrow-leaved *Carex,* and communicated by Mr. C. R. Orton, was used to sow, May 29, on *Ribes Cynosbati,* giving abundant infection with pycnia showing June 6, and aecia June 20. The rust was labelled by Mr. Orton *P. uniporula,* and our examination confirms this view, many urediniospores having been seen with one basal pore and none with equatorial pores. This does not, however, preclude the possibility of the infection coming from the three-pored form, which may be intermixed with the other, and the species is listed accordingly

[30] See North American Flora **7**: 231. 1912. For previous cultures see Mycol. **4**: 29. 1912; also Fraser in Mycol. **4**: 186. 1912.

[31] For previous cultures see Mycol. **4**: 61. 1912.

[32] For previous cultures see Jour. Myc. **14**: 23. 1908; Mycol. **1**: 240. 1909; **2**: 230. 1910; **4**: 25. 1912.

[33] For previous cultures see Mycol. **4**: 63. 1912.

as in the similar culture work of 1912, discussed above under number 1.

15. PUCCINIA VULPINOIDIS D. & H.—A collection of this rust on *Carex vulpinoidea* (host determined by Dr. Theo. Holm) made by Mr. Overholts at Elkton, Ohio, was used to sow April 17 on *Aster paniculatus, A. Drummondii, Solidago canadensis, S. glaberrima* (*S. missouriensis* of most manuals), *S. Rugosa,* and *S. mollis.* There was no infection of *Asters,* but a most abundant infection of the four species of *Solidago,* pycnia showing in each case April 27, and aecia May 7.

Puccinia vulpinoidis has been considered a distinctive and easily recognized species on account of the covered telial sori. A careful morphological study, chiefly by Dr. F. D. Kern, had shown however, that aside from this character the spore structure and range of hosts agree with *P. Caricis-Solidaginis,* or as we now say, *P. extensicola,* and to this morphological study was due the suggestion which led to the above successful cultures. The permanently covered telial sorus must be considered in the light of this study to be associated with the structural peculiarities of the host, and not a character to be used without qualification.

16. GYMNOSPORANGIUM CLAVARIAEFORME (Jacq.) DC.—Material on *Juniperus sibirica,* sent by Mr. Bethel from Tolland, Colo., was sown May 21 on *Crataegus cerronus* and gave rise to abundant pycnia June 1, but no aecia matured.[34]

17. PERIDERMIUM FUSIFORME Arth. & Kern.—Through the kindness of Dr. F. A. Wolf of Auburn, Ala., typical material of this striking rust was received, gathered from a grove of *Pinus taeda,* which Dr. Kern and myself had visited in April, 1912, and in which this form of *Peridermium* is very abundant.

The first collection, sent March 22, 1913, was from a main stem an inch in diameter, the fusiform gall being one and a half inches in diameter at the middle, and six inches long. It was sown March 24 on two plants of *Quercus rubra.* Uredinia began to appear sparingly on one plant by April 3, but failed to appear on the other, although telia developed on both plants April 14, in ample and perfect development.

[34] For previous cultures see Jour. Myc. 14: 19. 1908; Mycol. 1: 239. 1909; 4: 24. 1912; and 4: 56. 1912.

The second consignment was received April 5, 1913, consisting of a much larger gall, three inches in diameter by six inches long, but less typical in appearance. This material was sown April 6 on *Quercus rubra* and *Q. Phellos.* On the former, uredinia began to appear April 14, and on the latter April 18, followed by telia in both cases April 28.

This result shows without question that the form known under the name of *Peridermium fusiforme* is identical specifically with *P. Cerebrum,* both being the aecial stage of *Cronartium Quercus.* This cultural result is briefly referred to by Dr. Kern in Mycologia **6**: 112, 135. 1914. The non-appearance of the repeating stage in one case is an interesting phenomenon apparently connected with some condition of the host.

18. PERIDERMIUM CARNEUM (Bosc) Seym. & Earle.—Leaves of *Pinus taeda* bearing this rust were gathered by Prof. P. H. Rolfs, at Gainesville, Fla., February 12, 1913, and two days later were used by use to make a sowing on *Vernonia fasciculata.* Uredinia began to appear in abundance on March 3. Another collection of the rust was gathered by Mr. H. E. Stevens from *Pinus palustris* in the vicinity of Gainesville, Fla., on March 1. This material was from small plants in the open, over which leaves of *Ipomoea pandurata* well covered with *Coleosporium Ipomoeae* had been placed the previous fall. The field condition appeared to warrant the inference that the pine aecia were derived from the *Ipomoea* telia. A sowing of the material was made March 10 on *Vernonia fasciculata,* but no plants of *Ipomoea* were available for a culture. Uredinia appeared on the *Vernonia* in abundance on March 29, and in the typical form of *Coleosporium Vernoniae.*

This result does not preclude the possibility that *Coleosporium Ipomoeae* is a form of *C. Vernoniae,* but judging from the microscopic appearance of the urediniospores, that species is more likely to be a form of *C. Solidaginis* than of *C. Vernoniae.*

CULTURES IN 1914

19. PUCCINIA EXTENSICOLA Plowr.—A collection of the form known as *P. vulpinoidis,* collected by Mr. Travelbee and the writer

on *Carex vulpinoidea,* at Leland, Mich., Aug. 26, 1913, was used to sow April 2, on *Solidago canadensis* and *Aster paniculatus.* Abundant infection occurred on the *Solidago,* pycnia showing April 11, and aecia April 20, but the *Aster* remained free. The collectors found in many instances old aecia on *S. canadensis* in the field, intermixed with rusted *Carex vulpinoidea.* The inference from field observation, and also the cultural work of last year as recorded above under number 15, is confirmed by the culture.

A collection of *P. Dulichii* Syd., on *Dulichium arundinaceum,* gathered Jan. 17, 1914, at Gainesville, Fla., by Mr. H. E. Stevens, was accompanied by young aecia on a species of *Aster.* This association suggested that they might be genetically connected. A sowing from the *Dulichium* material was made, Jan. 22, on *Aster Drummondii, A. paniculatus,* and on an undetermined *Aster,* which had been obtained from a field near New Orleans, La., also on *Solidago canadensis* and *Senecio obovatus.* Another sowing from the same material was made, Jan. 31, on the same three species of *Aster,* and on *A. Tweedyi.* The only infection was a sparing production of pycnia on *Solidago canadensis,* showing Feb. 3, which did not continue into aecia. As soon as this result was noticed, another sowing from the same material was made, Feb. 4, on *Solidago canadensis,* which resulted in an abundant infection, showing pycnia Feb. 16, and aecia Feb. 25. From this result, together with a careful microscopic study of herbarium material, it is inferred that *P. Dulichii* is a part of the common *P. extensicola,* although the telial host is not a *Carex.* It is the first time that any Carex rust has been traced to a telial host outside of the genus *Carex.*

20. PUCCINIA TOSTA Arth.—A collection was made by Dr. Fromme and the writer at Mesilla Park, N. Mex., on what was thought at the time to be *Muhlenbergia Porteri,* but which later proved to be the very similar appearing *Sporobolus asperifolius.* Thinking that it was *P. Muhlenbergiae,* known to have its aecia on malvaceous hosts, it was sown, March 20, on *Callirhoe involucrata, C. digitata,* and *Sphaeralcea incana.* Infection was obtained only on the last host, pycnia showing March 27, and aecia April 3, both in great profusion. Another sowing was at once

made of the same material on *S. lobata, C. digitata, Hibiscus militaris,* and *Malvastrum coccineum,* with infection only on the *Sphaeralcea,* pycnia showing April 6, but the aecia being destroyed by aphis before maturing.

Another collection of identical appearance was made five days later than the one above, at Ysleta, Texas, a few miles from El Paso. This was sown, March 28, on two plants of *S. lobata,* on *C. digitata,* and *H. militaris.* Both plants of *Sphaeralcea* gave infection, showing pycnia April 6, but resulting in few aecia, owing to accident. Another sowing from the same collection was made, May 2, on *Napaea dioica,* without infection.

Putting the above cultural results from *P. tosta,* with the gross appearance and subsequent microscopic study, and comparing with similar data from *P. Muhlenbergiae,* there appears to be no ground upon which to keep the two forms separate. The fact that the telial hosts belong to two genera of grasses is not in this case a difference of importance, as *Sporobolus* and *Muhlenbergia* intergrade, and are kept separate upon technical grounds. The previous cultural studies[35] of *P. Muhlenbergiae* have indicated that the species is a complex of races. It has been grown on *Hibiscus militaris* and *Callirhoe involucrata,* but the similar aecia on *Napaea, Malvastrum,* and *Sidalcea* have not yet been grown, although attempted, the failure believed to be due to a lack of the proper racial telia. The above is the first successful culture with material on *Sporobolus,* although previous attempts[36] have been made.

Hereafter it will be considered advisable to treat *P. tosta* as a synonym of *P. Muhlenbergiae.*

21. PUCCINIA AGROPYRI E. & E.—A collection of this rust on *Elymus virginicus* was made by Dr. Fromme and the writer on Feb. 13, 1914, at Austin, Texas, and at the same time the observation was made that *Clematis Drummondii,* not then in leaf, was in the same spot, and abundant in the vicinity. Dormant roots of this wild Clematis were secured, and later grown for the culture work.

[35] See Jour. Myc. 11: 51. 1905; 13: 192. 1907; Mycol. 1: 251. 1909; 2: 226. 1910; and 4: 18. 1912.

[36] See Jour. Myc. 10: 10. 1904; 12: 12. 1906; Mycol. 4: 10 and 52. 1912.

A sowing of telia was made April 1 on *Clematis Drummondii, C. Douglasii, C. virginiana, Aquilegia flavescens, A. canadensis, Thalictrum Fendleri,* and *T. dioicum.* Abundant infection occurred on the first named host, but on no others, pycnia appearing April 5, and aecia April 18.

The results are in accord with the cultures of 1912, reported above under number 6, but indicate another race not met with before.

22. UROMYCES PERIGYNIUS Halst.—A collection of this species on *Carex tribuloides* made at French Lick, Ind., by Mr. Ludwig and the writer, was sown April 1 on *Aster paniculatus, A. Drummondii, A. Tweedyi, Solidago canadensis, S. rugosa,* and *Euthamia graminifolia.* Infection was secured only on *Aster Tweedyi,* and then so sparingly that it was overlooked until April 8, when the aecia were observed. Cultures for 1912 are reported above under number 8.

This species of rust from other *Carex* hosts has previously been been grown[37] on two other species of *Aster,* and five species of *Solidago.*

23. UROMYCES SCIRPI (Cast.) Burr.— Material on *Scirpus fluviatilis,* sent by Mr. E. T. Bartholomew from Madison, Wis., was sown April 22 on *Sium cicutaefolium,* giving rise to a few pycnia May 5, but without further development. Another similar sowing April 24 gave rise to an abundance of pycnia May 5, and aecia May 11.

The former cultures[38] with American material have been on *Cicuta maculata.*

24. GYMNOSPORANGIUM NIDUS-AVIS Thax.—Telial material on *Juniperus virginiana,* gathered by Dr. Fromme at Woods Hole, Mass., was sown May 11 on *Amelanchier vulgaris,* giving rise to pycnia May 19, and a great abundance of aecia June 20.[39]

25. GYMNOSPORANGIUM BOTRYAPITES (Schw.) Kern.—Telial material on *Chamaecyparis thyoides* sent by Dr. Fromme from Lakehurst, N. J., was sown May 6 on the leaves of *Amelanchier canadensis* and *Aronia arbutifolia,* with no infection on *Aronia,*

[37] Jour. Myc. 10: 15. 1904; and Mycol. 4: 32. 1912.

[38] Jour. Myc. 13: 199. 1907; 14: 17. 1908; and Mycol. 1: 237. 1909.

[39] For previous cultures see Jour. Myc. 14: 19. 1908; Mycol. 2: 230. 1910; 4: 25 and 56. 1912.

but very abundant infection on *Amelanchier*, giving pycnia May 18, and aecia October 1.

Another collection on the same host was sent by Dr. Fromme four days later from Woods Hole, Mass., and sown May 11 on leaves of *Amelanchier canadensis*, giving pycnia June 5, and aecia October 27. The results are in accord with previous cultures.[40]

26. COLEOSPORIUM VERNONIAE B. & C.—A collection of *Peridermium carneum* on *Pinus taeda*, gathered at East Lake, Fla., by Mr. H. E. Stevens, was sown April 13 on *Aster paniculatus, Solidago canadensis, Euthamia graminifolia, Laciniaria punctata, L. Langloisii* (the plant obtained from Texas), and *Vernonia fasciculata*. A sparing infection was obtained on the *Vernonia* only, uredinia being first noticed May 8.

A similar collection sent by the same collector from Gainesville, Fla., was sown May 8 on *Solidago canadensis, Laciniaria Langloisii, Elephantopus carolinianus, Amsonia salicifolia*, and *Vernonia fasciculata*. Although all the hosts used were possible hosts for such a *Peridermium*, yet infection only occurred on the *Vernonia*, showing uredinia May 25 in abundance.

Uredinia from the last culture was sown May 17 on another plant of *Vernonia fasciculata*, with abundant infection, showing uredinia May 26. Another sowing from the same source was made May 28 on *Aster paniculatus* and *Laciniaria Langloisii*, with no infection.

The results are in accord with previous cultures,[41] and add but little to our knowledge of the numerous southern species of *Coleosporium*.

SUCCESSFUL CULTURES REPORTED NOW FOR THE FIRST TIME: The following species have never before been cultivated, in America or elsewhere, so far as the writer knows. Some of those included in the above list, such as *Puccinia vulpinoidis, P. Dulichii, P. tosta*, and *Peridermium fusiforme*, might with some propriety have been placed here, as not till after the cultures were made was their true status as species known.

[40] Mycol. 1: 240. 1909.

[41] Mycol. 4: 29 and 57. 1912.

CULTURES IN 1913

1. UROMYCES ELEGANS (B. & C.) Lagerh.—This autoecious rust, very common in the Southern States, is one of the group of species which produce no uredinia, so far as known, very few of which have been cultivated. Growing plants of *Trifolium carolinianum* bearing aecia were sent by Dr. F. A. Wolf from Auburn, Ala., and the aeciospores sown March 29 on plants free from the fungus. Teliospores began to appear about April 18 as the result.

This result does not disclose whether the species possesses both primary and secondary aecia, or whether pycnia ever occur. A culture with teliospores should be kept in view.

CULTURES IN 1914

2. PUCCINIA NODOSA Ell. & Hark.—While upon a visit to the Desert Botanical Laboratory at Tucson, Ariz., an exceptional opportunity was offered to study the life history of another autoecious species of rust, which like the one last mentioned, possesses no uredinia. A strong plant of *Brodiaea pauciflora*, growing near the door of the laboratory was moistened on February 26, sprinkled with aeciospores brought from some distance, and covered with a belljar. The temperature at the time was favorable for infection, the belljar being shielded from the direct rays of the sun. The experiment was left in charge of Dr. W. A. Cannon of the Laboratory staff, who kindly forwarded the leaves on March 18, when the sori first opened. Only telia were produced.

As in the preceding case the possibility of both primary and secondary aecia occurring in the life cycle is not touched upon.

3. PUCCINIA SPLENDENS Vize.—Through the courtesy of the Desert Botanical Laboratory, Dr. Fromme and the writer were enabled to make an excursion on February 28 to the Santa Rita Mountains in the vicinity of Tucson, Ariz., where we secured teliosporic specimens of *P. splendens* on *Hymenoclea monogyra*. Through the kindness of Prof. J. J. Thornber of the University of Arizona we received after our return to Indiana a number of thrifty young plants of this host, which soon started into leaf in the green house. A sowing of teliospores was made April 7,

and another April 15, with no result. A third sowing on April 25 was better done, and gave rise to pycnia on the leaves May 6, and aecia May 20.

Aeciospores from this culture were sown May 26, which resulted in the production of uredinia June 15, not numerous but well formed. Uredinia continued to be produced until they were finally followed sparingly by telia July 10.

In every sowing an abundance of spores was used, which were applied to both leaves and stems. Tests of the spores showed unusually strong germination. Why the infection was so sparing and only on the leaves, while in the field the rust is chiefly on the stems, was not apparent. The cultures supply a knowledge of the pycnia and uredinia, neither of which were before known.

4. PUCCINIA MINUTISSIMA Arth.—Viable material of this species on *Carex filiformis* was secured at much labor especially for this work by Mr. J. Dearness of London, Ontario, from the southeastern shore of Lake Huron. A collection made in December, 1911, was sown the following spring on seven hosts of as many genera without infection. Another collection of May, 1912, was similarly tested, and even more thoroughly, without success. A collection made in November, 1913, was sown April 18, 1914, on *Decodon verticillatus,* with an abundant infection, showing pycnia April 27, and aecia May 7.

The first suggestion for this connection was made by Prof. James B. Pollock of the University of Michigan, who wrote on August 3, 1909, as follows: "I found a rust on a patch of *Carex filiformis,* forming a half circle with a radius of about two rods around a specimen of *Decodon verticillatus,* some of whose leaves had an *Aecidium* on them. I send herewith specimens of both. No other *Aecidium* was found near the rusted sedge. The whole situation seems to me to indicate very closely the Decodon plant as a center of infection for the *Carex* rust."

The aecial stage of this rust is *Aecidium Nesaeae* Ger., but *Puccinia Nesaeae* Ellis & Ev. does not belong here, having been founded on a telial collection with the host erroneously determined. The error was detected by Prof. E. W. D. Holway.

5. GYMNOSPORANGIUM ELLISII (Berk.) Farl.—Material on *Chamaecyparis thyoides* was sent by Dr. Fromme from Lakehurst

N. J., and sown May 6 on *Myrica cerifera*, giving rise to pycnia May 15, and aecia June 6. This most interesting result was in accord with field observations made by Dr. Fromme, who has recorded the steps which led to the inference of relationship, and has also discussed the results, in a paper[42] anticipating this report.

The aecia of this species are of the aecidioid form, and not roestelioid, as in the majority of the species of the genus. Moreover, the host belongs to a family more divergent from the Malaceae, which bears most of the Gymnosporangial aecia, than heretofore supposed to be possible. The telial stage was once made the basis of a separate genus, *Hamaspora*, on account of the slender, more than two-celled teliospores. Completing a knowledge of the life history of a species with so many outlying characters is an especially notable achievement.

SUMMARY

The following is a complete list of the successful cultures made during the years 1912, 1913, and 1914. It is divided into two series, species that have previously been grown in cultures and reported by the writer or other investigators, and species whose culture is now reported for the first time.

A. SPECIES PREVIOUSLY REPORTED

1, (8) and 14. PUCCINIA GROSSULARIAE (Schum.) Lagerh. (*P. albiperidia* Arth., *P. quadriporula* Arth.)—Teliospores from *Carex arctata* Boott, *C. crinita* Lam., *C. pubescens* Muhl., and *C. tenuis* Rudge, sown on *Ribes Cynosbati* L.

2, 15 and 19. PUCCINIA EXTENSICOLA Plowr. (*P. Caricis-Asteris* Arth., *P. Caricis-Solidaginis* Arth., *P. vulpinoidis* D. & H., *P. Dulichii* Syd.).—Teliospores from *Carex retrorsa* Schw., sown on *Aster paniculatus* Lam.; from *Carex scoparia* Schk., sown on *A. paniculatus* Lam. and *Euthamia graminifolia* (L.) Nutt.; from *Carex vulpinoidea* Michx., sown on *Solidago canadensis* L., *S. glaberrima Martens*, *S. rugosa Mill.* and *S. mollis* Barth.; from *Dulichium arundinaceum* (L.) Britt., sown on *Solidago canadensis* L.

[42] Fromme, D. A. A new Gymnosporangial connection. Mycol. **6**: 226–230. 1914.

3. PUCCINIA ANGUSTATA Peck.—Teliospores from *Scirpus atrovirens* Muhl., sown on *Lycopus americanus* Muhl.

4. PUCCINIA ELLISIANA Thüm.—Teliospores from *Andropogon* sp., sown on *Viola cucullata* Ait. and *V. Nuttallii* Pursh.

5. PUCCINIA STIPAE Arth.—Teliospores from *Stipa comata* Trin. & Rupr., sown on *Gutierrezia Sarothrae* (Pursh) B. & R., and *Senecio spartioides* T. & G.

6 and 21. PUCCINIA AGROPYRI E. & E.—Teliospores from *Elymus canadensis* L., sown on *Clematis ligusticifolia* Nutt., and *Anemone cylindrica* A. Gray; from *Elymus virginicus* L., sown on *Clematis Drummondii* T. & G.; and from *Agropyron Smithii* Rydb., sown on *Clematis ligusticifolia* Nutt.

7. PUCCINIA MONOICA (Peck) Arth.—Teliospores from *Trisetum subspicatum* (L.) Beauv., sown on *Arabis* sp., and aeciospores from *Arabis* sp., sown on *Koeleria cristata* (L.) Pers.

20. PUCCINIA MUHLENBERGIAE A. & H. (P. *tosta* Arth.).—Teliospores from *Sporobolus asperifolius* (Nees & Meyen) Thurb. sown on *Spaeralcea incana* Torr. and *S. lobata* Wooton.

8 and 22. UROMYCES PERIGYNIUS Halst.—Teliospores from *Carex intumescens* Rudge, sown on *Aster paniculatus* Lam., and *Solidago canadensis* L.; from *Carex tribuloides* Wahl., sown on *Aster Tweedyi* Rydb.

9. UROMYCES JUNCI (Desm.) Tul.—Teliospores from *Juncus balticus* Willd., sown on *Ambrosia psilostachya* DC., *A. trifida* L., and *Carduus Flodmanni* Rydb.

10. UROMYCES ACUMINATUS Arth.—Teliospores on *Spartina Michauxiana* A. S. Hitch., sown on *Collomia linearis* Nutt.

23. UROMYCES SCIRPI (Cast.) Burr.—Teliospores from *Scirpus fluviatilis* (Torr.) A. Gray, sown on *Sium cicutaefolium* Schrank.

11. GYMNOSPORANGIUM NELSONI Arth. (*G. durum* Kern).—Teliospores from *Juniperus scopulorum* Sarg., sown on *Amelanchier canadensis* (L.) Medic.

12. GYMNOSPORANGIUM BETHELI Kern.—Teliospores from *Juniperus scopulorum* Sarg., sown on *Crataegus Pringlei* Sarg.

13. GYMNOSPORANGIUM GRACILENS (Peck) Kern & Bethel.—Teliospores from *Juniperus utahensis* (Engelm.) Lemmon, sown on *Philadelphus coronarius* L. and *P. Keteleerii* Carr.

16. GYMNOSPORANGIUM CLAVARIAEFORME (Jacq.) DC.—Telio-

spores from *Juniperus sibirica* Burgsd., sown on *Crataegus cerronus* A. Nels.

24. GYMNOSPORANGIUM NIDUS-AVIS Thax.—Teliospores from *Juniperus virginiana* L., sown on *Amelanchier vulgaris* Moench.

25. GYMNOSPORANGIUM BOTRYAPITES (Schw.) Kern.—Teliospores from *Chamaecyparis thyoides* (L.) B. S. P., sown on *Amelanchier canadensis* (L.) Medic.

17. CRONARTIUM QUERCUS (Brond.) Schröt. (*Peridermium fusiforme* Arth. & Kern).—Aeciospores from *Pinus taeda* L., sown on *Quercus rubra* L., and *Q. Phellos* L.

18 and 26. COLEOSPORIUM VERNONIAE B. & C.—Aeciospores from *Pinus taeda* L. and *P. palustris* Mill., sown on *Vernonia fasciculata* Michx.; *urediniospores* from *Vernonia fasciculata* Michx., sown on same host.

B. SPECIES REPORTED NOW FOR THE FIRST TIME

1. UROMYCES ELEGANS (B. & C.) Lagerh.—Aeciospores from *Trifolium carolinianum* Michx., sown on same host, producing telia.

2. PUCCINIA NODOSA Ell. & Hark.—Aeciospores from *Brodiaea pauciflora* (Torr.) Standley, sown on same host, producing telia.

3. PUCCINIA SPLENDENS Vize.—Teliospores from *Hymenoclea monogyra* T. & G., sown on same host, producing pycnia and aecia; aeciospores sown on same host, producing uredinia and telia.

4. PUCCINIA MINUTISSIMA Arth. (*Aecidium Nesaeae* Ger.)—. Teliospores from *Carex filiformis* L., sown on *Decodon verticillatus* (L.) Ell.

5. GYMNOSPORANGIUM ELLISII (Berk.) Farl.—Teliospores on *Chamaecyparis thyoides* (L.) B.S.P., sown on *Myrica cerifera* L.

PURDUE UNIVERSITY,
LAFAYETTE, INDIANA.

PHOTOGRAPHS AND DESCRIPTIONS OF CUP-FUNGI—I. PEZIZA

FRED J. SEAVER

(WITH PLATES 155 AND 156, CONTAINING 4 FIGURES)

Although the type of the genus *Peziza* is in doubt, the name stands in current usage as it doubtless should continue to do, for the large fleshy cup-fungi. Notwithstanding the number of segregates which have been made on one character or another, the genus is still represented by a fairly large number of species.

Many of the species of the genus cannot be satisfactorily studied from dried specimens alone, since the more conspicuous characters, such as color, form, etc., are entirely lost in this condition. In a number of species, the spores furnish valuable diagnostic characters, but in other cases we must rely entirely on gross character. For this reason, the species of the genus should be accompanied by complete field notes, or as is still better, by colored sketches or photographs or both.

The reproduction of the plants of this group by photographs while inferior in many ways to reproduction by color, is less expensive and shows many fine details which are lost even in the best colored illustrations. For these reasons, it is the intention to bring out from time to time illustrations of the common species of *Peziza* and other cup-fungi in such a way as to aid in determining the identity of these plants as they are collected in the field. The following illustrations represent four of the common species of *Peziza*, the photographs having been made from local specimens collected by the writer in the vicinity of New York City.

PEZIZA BADIA Pers. Obs. Myc. **2**: 78. 1799

?Peziza cochleata L. Sp. Pl. 1181. 1753.
?Helvella cochleata Bolton, Fungi Halifax **3**: 99 (in part). 1789.
Plicaria badia Fuckel, Symb. Myc. 327. 1869.
Aleuria badia Gill. Champ. Fr. Discom. 43. 1879.

Apothecia scattered, gregarious or more commonly cespitose, sessile, at first globose, expanding and becoming deep cup-shaped, regular in form, or infolded and cochleate or auricular, occasionally one-sided and rarely *Otidea*-like, externally varying from tan-colored when young to dark-brown with age, whitish near the base, pustulate, the pustules often reddish or purplish, becoming dark with age, reaching a diameter of 10 cm.; hymenium dark-brown; asci tapering below and often forked at the base, cylindric above; spores 1-seriate, usually oblique and often irregularly crowded, ellipsoid, with the ends quite strongly narrowed, becoming verrucose, hyaline or very faintly colored, 17–23 × 8–10 μ; paraphyses rather strongly enlarged above, yellowish.

On the ground in deciduous woods.

TYPE LOCALITY: Europe.

DISTRIBUTION: New York to Oregon, California and Alabama; also in Europe.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 283;* Bull. Lab. Nat. Hist. State Univ. Iowa **6**: *pl. 14, f. 2, pl. 15, f. 1;* Cooke, Mycographia *pl. 57, f. 226;* Gill. Champ. Fr. Discom. *pl. 42.*

EXSICCATI: Ellis & Ev. N. Am. Fungi *981.*

Peziza cochleata of Linnaeus is a species of doubtful identity. Persoon in 1801 described *Peziza badia* and cited as a synonym *Helvella cochleata* Bolton. Bolton apparently included in his description two species, one of which is commonly taken to be identical with *Peziza badia* as at present known. Bolton's *Helvella cochleata* represents his conception of *Peziza cochleata.* Some modern authors are inclined to regard *Peziza cochleata* L. as an *Otidea.* In the absence of any definite information, the writer is inclined to adhere to the early conceptions of Bolton and Persoon and regard *Peziza cochleata* L. as at least a doubtful synonym of the present species.

PEZIZA VESICULOSA Bull. Herb. Fr. *pl. 457.* 1789

?Helvella cochleata Bolton, Fungi Halifax **3**: 99 (in part). 1789.
Pustularia vesiculosa Fuckel, Symb. Myc. 329. 1869.
Aleuria vesiculosa Gill. Champ. Fr. Discom. 45. 1879.

Apothecia gregarious or more often densely cespitose, at first closed and globose, gradually expanding and becoming deep cup-shaped, regular in form or irregularly contorted, sessile or with

very stout stem-like base, externally whitish or yellowish, pustulate from the presence of minute warts, reaching a diameter of 7–8 cm.; hymenium pale-brown, darker than the exterior of the apothecium; asci cylindric or subcylindric; spores obliquely 1-seriate, ellipsoid, smooth, hyaline, 20–23 × 10–11 μ; paraphyses enlarged above, granular within, subhyaline.

On manure piles and rich soil.

TYPE LOCALITY: France.

DISTRIBUTION: New York to Washington, California and Alabama; probably throughout North America; also in Europe.

ILLUSTRATIONS: Bull. Herb. Fr. *pl. 457;* Boud. Ic. Myc. *pl. 257;* Cooke, Mycographia *pl. 63, f. 242;* Gill. Champ. Fr. Discom. *pl. 44;* Rabenh. Krypt. Fl. 1[3]: 992, *f. 1–4;* Bull. Lab. Nat. Hist. State Univ. Iowa **6**: *pl. 16, f. 1;* Sowerby, Engl. Fungi *pl. 4;* Massee, Brit. Fungus Fl. **4**: 290, *f. 22.*

EXSICCATI: Ellis, N. Am. Fungi *1270.*

PEZIZA PUSTULATA (Hedw.) Pers. Syn. Fung. 646. 1801

Octospora pustulata Hedw. Musc. Frond. **2**: 19. 1787.
Plicaria pustulata Fuckel, Symb. Myc. 327. 1869.
Peziza assimilata Karst. Not. Fauna Fl. Fenn. **10**: 113. 1869.
Aleuria pustulata Gill. Champ. Fr. Discom. 45. 1879.
Peziza umbrina Boud.; Cooke, Mycographia 226 (in part). 1879.

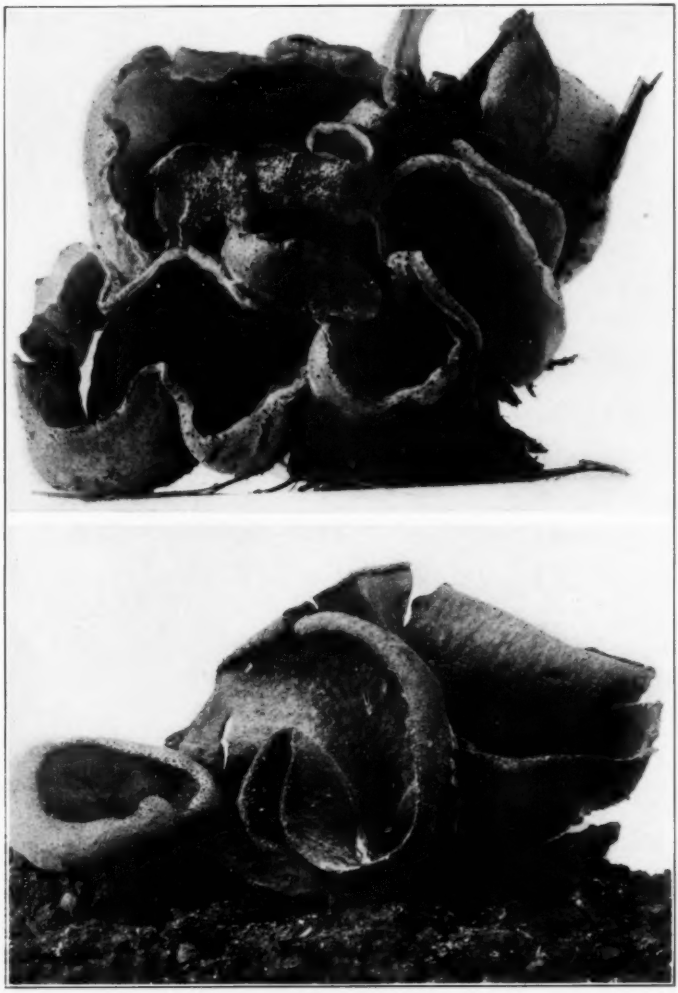
Apothecia gregarious, scattered or cespitose, at first closed and globose, gradually expanding, reaching a diameter of 3–5 cm., regular or much contorted, externally whitish and densely pustulate, the pustules giving rise to bran-like particles as the plant matures, margin usually crenate; hymenium pale- to dark-brown; asci cylindric above, reaching a length of 275 μ and a diameter of 12–14 μ; spores 1-seriate, ellipsoid, becoming minutely roughened, hyaline to faintly yellowish, 15–17 × 10 μ; paraphyses strongly enlarged and reaching a diameter of 7–8 μ.

On charcoal and burned areas.

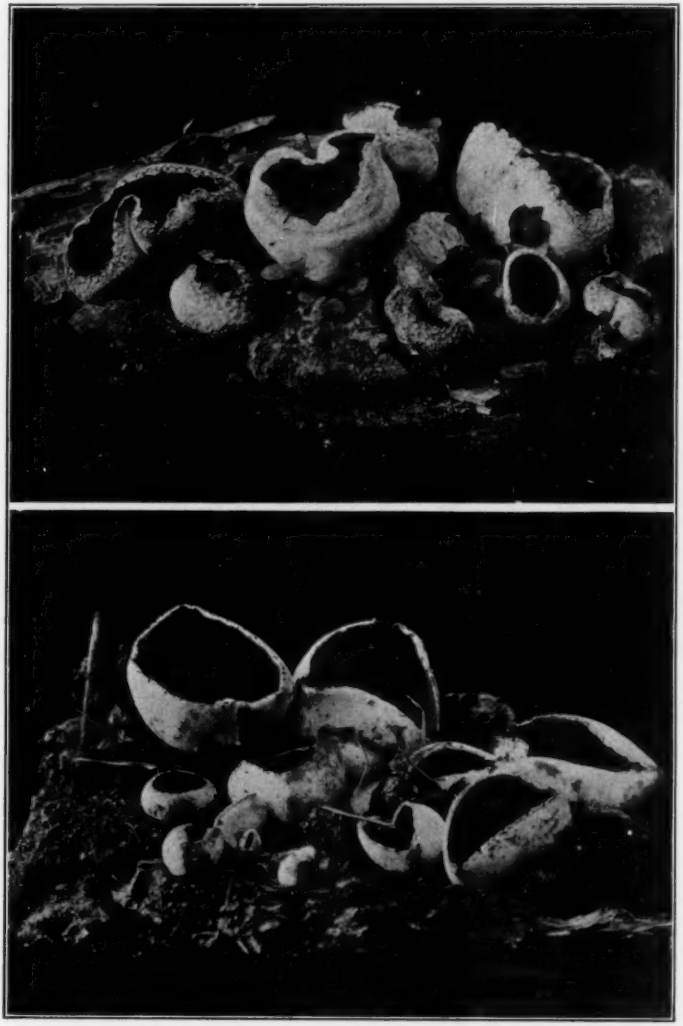
TYPE LOCALITY: Europe.

DISTRIBUTION: New York to Wisconsin; also in Europe.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 279;* Cooke, Mycographia *pl. 106, f. 378;* Grevillea **2**: *pl. 24, f. 2;* Hedw. Musc. Frond. **2**: pl. *6, f. 1–4;* Gill. Champ. Fr. Discom. *pl. 47, f. 2.*



PEZIZA VESICULOSA BULL.
PEZIZA BADIA PERS.



PEZIZA PUSTULATA (HEDW.) PERS.
PEZIZA SYLVESTRIS (BOUD.) SEAVER

Peziza sylvestris (Boud.)

Aleuria sylvestris Boud. Hist. Class. Discom. Eu. 45. 1907.

Apothecia gregarious, sessile, deep cup-shaped to subdiscoid, externally whitish, nearly smooth or pustulate, the margin even or slightly wavy and crenate, reaching a diameter of 3–8 cm.; hymenium umber-brown; asci cylindric above, gradually tapering below, reaching a length of 300–325 μ and a diameter of 13–15 μ; spores 1–seriate, with the ends slightly overlapping, hyaline, smooth, 17–20 $\times$ 9–10 μ; paraphyses strongly enlarged above, reaching a diameter of 7–8 μ at their apices.

On rubbish piles and soil in woods.

TYPE LOCALITY: Europe.

DISTRIBUTION: New York; also in Europe.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 261.*

The species listed under this name is common about New York City. While agreeing with Boudier's description and illustrations, it is not unlikely that the species has been previously described. From our own observations, the species seems quite variable both in size and appearance, the apothecia being sometimes nearly plane and occasionally strongly warted and then resembling *Peziza bufonia* Pers. The species differs from *Peziza pustulata* in the habitat and in the spores, those of the former being strongly roughened and those of the present species permanently smooth. The size and color of the two species is almost identical.

NEW YORK BOTANICAL GARDEN.

EXPLANATION OF PLATES

PLATE CLV

Upper figure, *Peziza vesiculosa* Bull.
Lower figure, *Peziza badia* Pers.

PLATE CLVI

Upper figure, *Peziza pustulata* (Hedw.) Pers.
Lower figure, *Peziza sylvestris* (Boud.) Seaver.

THE STRUCTURE AND DEVELOPMENT OF SECOTIUM AGARICOIDES

HENRY S. CONARD

(WITH PLATE 157 AND 1 TEXT FIGURE)

This curious fungus was first found in Ukrain by Czerniaiev in 1845. Specimens from America described by Peck (1882) as *S. Warnei* were examined by Hollós (1903) and pronounced specifically identical with the European plants. This conclusion seems fully justified so far as can be judged by the excellent colored plate and full description given by Czerniaiev. It is therefore a plant of very wide distribution. Hollós records it from Ohio to Wisconsin and Kansas in North America, as well as from Europe, Asia, Africa (Algeria), New Zealand, and Australia (Banks Peninsula).

Secotium agaricoides resembles a puffball in general appearance, being from 4 to 6 or 8 cm. in diameter; but it stands on a short stalk, and the stalk continues through the body of the fungus as a columella. The interior is filled with branched and much folded lamellae instead of a capillitium. Sometimes the body does not dehisce at all; in other cases, it splits lengthwise or the peridium separates slightly from the stalk after the manner of an agaric. The spores are olive-brown in color when seen in mass. They are ovoid in shape and measure $7 \times 5\ \mu$. They have smooth, thick, impervious walls, with one apical germ pore. They are borne in fours on rather long sterigmata, upon clavate basidia, which at maturity are about $22 \times 6\ \mu$. The spore often carries with it a part of the sterigma as an appendage. The present study attempts to throw some light on the nature of this curious plant from the standpoint of development.

My material consisted of about 100 mature plants and 6 small young ones. One 13 mm. and one 15 mm. in diameter were collected in 1911. The others, 10 mm. tall and 8 mm. in diameter, 10 mm. tall and 9 mm. in diameter, 4 mm. tall and 3.8 mm. in

diameter, and 4 mm. tall and 3.5 mm. in diameter, were collected in 1912. All were cut open, fixed in chromo-acetic acid, sectioned in paraffin $3\frac{1}{3}$, $6\frac{2}{3}$, or 10 microns thick, and stained with various stains. The best results were obtained with Haidenhain's iron-alum-haematoxylin. The mature specimens were dry when collected and were stored in boxes.

Development.—The youngest specimens are nearly globular, white, and smooth. Then comes a "button" stage, with the upper portion slightly larger than the stalk and the surface still smooth. Later, the fertile portion increases greatly in height and diameter, leaving the free stalk as a mere basal projection. The superficial brown scales of the peridium appear only when near full maturity. The spores are fully mature while the trama, peridium, and stalk are still fleshy. The old specimens, at least in our climate, dry up and do not putrify.

The Peridium.—Sections of the 3.5 mm. specimen show an indefinite outer layer of loosely woven hyphae surrounding a dense mass of closely packed threads (Pl. 157, fig. 1). Within this globular body and near its summit a ring of deeply-staining tissue is already found. This is the fundament of the hymenophore. In older specimens, the hymenophore hyphae take a distinctly radial and longitudinal direction and form a thick and well-marked zone. Between this layer and the outer webby portion, the hyphae are less crowded and take a paler stain. Their course is predominantly longitudinal (radial). This layer is continuous below with the substance of the stalk. At this stage (9 mm. in diameter), the outer webby layer is more prominent and continues down upon the stalk of the "button." Soon after this, however, the layer completely disappears. The mature peridium shows only a broad layer of longitudinal hyphae, with a thin superficial layer of crushed and withered threads.

The outermost loose layer of the young plant (Pl. 157, fig. 5, 6) agrees in structure and position with the universal veil or blematogen of the evolvate agarics (*Agaricus,* Atkinson 1906, 1914a; *Armillaria,* Atkinson 1914b; and *Stropharia,* Zeller 1914). The second layer forms the bulk of the tissue of the peridium.

The mature peridium is fleshy to leathery in texture. It is about 2 mm. thick on the sides of the body, thinning below to nothing

when it breaks away from the stalk, and thickening above to its union with the columella. The scales on its surface are not separate from it, but when caught with forceps and peeled off, the tissue tears deeper and deeper into the peridium. The summit of the columella is continuous with the peridium and of similar structure.

In our 9 mm. specimen, there is a layer of open-meshed "neutral tissue" just within the gleba, surrounding the lower part of the columella. This layer is broadest where the peridium joins the stalk. It probably represents the layer of stem tissue which in *Agaricus campestris* is torn off with the annulus in the expansion of the cap. It appears only in this one specimen. In the 13 mm. specimen, the pileus or peridium joins the stipe by a broad confluence of tissues, representing the undifferentiated partial veil. At the line of junction, the hyphae appear greatly tangled, for the hyphae of the stipe run approximately longitudinally and are continuous with those of the columella, and the prevailing direction in the peridium is meridional. It is doubtless along this tangled region that marginal dehiscence occurs.

The Hymenophore.—The hymenophore appears in the 3 mm. specimen as a horizontal ring of deeply-staining tissue within the globular fungous body and near its summit (Pl. 157, fig. 1). The hyphae composing this ring are rich in protoplasm and very densely tangled together. They do not appear to follow any one direction more than another. Their ends are simply rounded.

In the 3.8 mm. specimen (Pl. 157, fig. 2), this dense ring of hyphae has organized a distinct palisade of round-tipped threads. A median longitudinal section of the carpophore shows this already in two deeply stained lunate areas, concave downward. The tissue beneath these patches is very loose and open, with an occasional lacuna (fig. 4). No sign of gills yet appears in tangential sections (fig. 3). Already, however, the palisade hyphae are swollen at the ends to form basidia and under these basidia the first formation of the gill chamber takes place by a tearing away of the underlying hyphae. The palisade is evidently spreading both centripetally and centrifugally. The centripetal advance encroaches on the stipe for a short time and then ceases. This causes the decurrence of the lamellae, mentioned later. The centrifugal spreading is much more rapid and continues as the "mar-

ginal growth of the pileus" until the mature size of the carpophore is reached. The boundary of the pileus is first evident in the upper part of the 3.8 mm. specimen. Thus, the hymenophore distinctly precedes the pileus and the gill chamber in differentiation.

Just how the circle of palisade gives rise to the gill system, my material does not show. My next stage (9 mm., fig. 5, 6) has a ring of well-formed gills extending from the cap toward the columella. The gills are much branched and anastomosing. They run primarily in a radial direction. Near the apex of the body, the gills are united with the columella, or in other words are decurrent (fig. 6, *a*). An older specimen shows the tramal tissue apparently continuous with the columella in many places. This is doubtless the result of a secondary mingling of hyphae, for in mature specimens the gleba is everywhere adherent to the columella, while in the 10 mm. specimen there is a distinct air cavity between the gills and the columella. Growth of the gills is chiefly marginal, though apparently folds may originate and develop at any place. The extension of the gill system as a whole takes place in the region where the peridium joins the stem; corresponding to the marginal or centrifugal extension of agarics (fig. 6, *b*). In this region, the hyphae are narrow, protoplasmic, densely crowded, nearly parallel, and curved downward and inward. They have simple rounded ends. As general growth of the fertile portion of the carpophore goes on, a loosening of the tissues between this growing zone and the stem occurs and into this loose region the hymenophore hyphae constantly penetrate. Quickly the hyphae branch and form a dense hymenium of long, clavate basidia.

The mature gills are much branched and folded. The tramal tissue consists wholly of long, branching, and nearly parallel hyphae, whose ultimate branchlets form the densely crowded basidia. There are no cystidia or other aberrant cells. From a fairly dense web in growing stages, the trama becomes looser toward maturity and finally becomes dry and fragile. From the above account, it is clear that the carpophore of *Secotium agaricoides* presents in its origin and development an exact counterpart of that of *Agaricus* (Atkinson 1906, 1914a). There is at

first a universal veil like that of several evolvate agarics (*Agaricus, Armillaria,* and *Stropharia*). There is an ill-differentiated partial veil. The origin of the hymenophore agrees precisely with that of all recently reported agarics, except *Hypholoma* (Allen 1906) and *Coprinus* (Levine 1914). The marginal growth of the gill system is also familiar in the mushrooms. The columella comes into being exactly as does the stipe of mushrooms. Indeed, we might well speak of stipe and pileus of *Secotium,* rather than of peridium and columella. The basidia and spores have the shape, size, and arrangement found in agarics. The copious branching of the gills exceeds anything seen in agarics. The failure of the cap and gills to expand, the drying up of the trama into a friable mass of tissues and spores, the olive-brown color of the spores, and the freedom of the spores to "puff" when the exposed mass is touched, are all lycoperdinean characters.

Histology and Cytology.—The cell structures of *Secotium* present nothing novel. In the sections showing the earliest fundament of the hymenophore, there are in the ring of active growth a few hyphae which are twice as stout as the others; they stain of an even dark color with haematoxylin, without granules of any kind. In the 9 mm. specimen, many hyphae in the stipe, columella, pileus, and trama stain deep-red with safranin. They are of the usual diameter and show no granules. As the stem of this specimen is bored by insect larvae (fig. 6), these may be dead hyphae. They are absent from the region of active growth at the margin of the pileus.

The cells of the mycelium vary from 2 to 10 times as long as wide. The end walls usually show the little central mass of stainable material associated by Strasburger with the pores in the partition (fig. 1, 5). In several instances, the cells of the tramal hyphae had two distinct nuclei. Metachromatic bodies are numerous, especially in the hymenium and regions of active growth. Many paler bodies were seen along the walls of some cells.

The rhizomorph connected with the base of the carpophore in my 3.8 mm. specimen is composed of three kinds of hyphae. (1) Most hyphae are very slender (3.5 microns), homogeneous or slightly granular. They form the fundamental tissue of the entire structure (fig. 1, 11). (2) Among these are groups or

strands of larger hyphae (fig. 1, 11), and occasionally very large ones (10 microns). These show distinct nuclei, certain globular bodies, and numerous square crystals (fig. 1, 13). As the crystals stain deeply, they are probably of protein, as found by van Bambeke in *Lepiota meleagris*. The course of these larger hyphae is mostly longitudinal, but they are much tangled. They are not found in the carpophore. (3) On the surface of the rhizomorph, are many slender (2.5 to 3 microns) hyphae with very thick walls (1 micron, fig. 1, 12); in places they form a rather compact layer, but they occasionally extend into the center of the rhizomorph. The walls stain both with haematoxylin and eosin; no contents were observed.

The young basidium possesses two nuclei near the middle of the cell (fig. 1, 12), usually lying in the longitudinal axis of the cell. These nuclei, like those of the mycelium generally, are small, sharply outlined, with one large nucleolus and little or no other visible substance. Later a single large nucleus of similar structure is found near the distal end of the basidium (fig. 1, 6, 8). Although satisfactory fusion stages were not found (fig. 1, 3, 4), there is doubtless a fusion of nuclei to form this one large nucleus. Still later, two (fig. 1, 7) and then four nuclei are found, clustered about the apex of the basidium (fig. 1, 8). The mitoses were not observed. The four sterigmata then grow out symmetrically and a spore forms on each (fig. 1, 9, 10). The entrance of the nuclei into the spores was not observed, but some of the spores were clearly seen to possess a single nucleus.

So far as observed, then, the cytology of *Secotium* agrees with that of other hymenomycetes.

Discussion.—What of the relationships in general? Fischer (1899) in the Pflanzenfamilien admits "about twenty species" of *Secotium*, including the genera *Endoptychum* Czern. and *Elasmomyces* Cav. The gill structures of *S. erythrocephalum* Tul. and *S. Mattirolianus* (Cav.) agree well with those of *S. agaricoides* (Czern.), but Cavara (1897) describes a large-celled pseudoparenchyma in the stipe and peridium of his species. This tissue occurs in layers alternating with layers of hyphal tissue. The spores, also, of *S. Mattirolianus* are rough, roundish, and of two sizes. Cystidia occur in Cavara's species, as also according to

Corda (1854) in *S. Gueinzii* Kunze. No cysts are described by Corda for *S. melanosporum* Berk. or *S. coarotatum* Berk. If, therefore, Fischer has done well in uniting *Endoptychum* and *Elasmomyces* with *Secotium,* we must recognize two or perhaps three well marked subgenera. The other species of *Secotium* are not well enough known to admit of discussion.

Regarding the other genera united with *Secotium* by Fischer (1899) in his Secotiaceae, *Polyplocium,* as Fischer himself notes, is nearer to *Boletinus* than it is to *Secotium. Gyrophragmium* may prove to be near to *Secotium,* but Fischer regards it as close to *Montagnites* and *Coprinus,* to which *Secotium* is certainly not closely allied. As to *MacOwenites* and *Cauloglossum,* too little is known of them, but they do not seem to resemble *Secotium* so closely as the latter resembles *Agaricus.*

The Hysterangiaceae and Hymenogastraceae which make up the rest of the Hymenogastrineae of Fischer are each fairly homogeneous in themselves. They relate quite distinctly to the Clathraceae, Lycoperdacaeae, and Nidulariaceae. They resemble Secotiaceae only in the fact that their spores mature while the hymenophore is still fleshy. But this is equally true of Agaricaceae. There remains therefore no real unity in Fischer's Hymenogastrineae and that author's opinion seems strengthened that the Secotiaceae, at least should be dismembered and its genera distributed among the Hymenomycetes.

Fischer (1900) and Lotsy (1907) have considered *Secotium* as a possible point of departure for the Phallaceae. Lotsy refers directly to the little known *S. olbium.* The argument is based on the manner of development of the hymenophore. Further, Corda's figure of *S. Gueinzii* (Pl. 6, fig. 12) shows trabeculae running through the gleba from the top of the stipe to the peridium, after the manner of a young clathroid, but Corda's section cannot be median, as it shows no columella; and it throws no light on the origin of the hymenophore. We have seen that in respect to development *S. agaricoides* is precisely like *Agaricus campestris* and *A. arvensis* as described by Atkinson (1906, 1914a). It is not like *Phallus* or *Mutinus,* nor can the stipe and columella of *Secotium* be likened to the stalk of a phalloid; for the phalloid stem probably represents a sterilized gleba, and is therefore

comparable with the sterile base of a *Lycoperdon*. But the columella of *Secotium agaricoides* is in its origin, development, and structure strictly agaricinean. There would seem to be no support whatever for relating our plant to the Phallaceae. The likeness of *Secotium* to a puffball as noted on a previous page, though quite real, is decidedly superficial, and cannot carry much weight.

On the whole, *S. agaricoides* would best be placed near to *Agaricus* (*Psalliota*), either in the Agariceae or Marasmiae of Hennings (1897). It clearly falls within the Agaricaceae of Maire (1902). It is to be regarded as a primitive or arrested agaric,—perhaps a paedogenic form, reaching its reproductive maturity in the "button" stage.

SUMMARY

1. *Secotium agaricoides* is a widespread species, occurring in Europe, Asia, Africa, North America, Australia, and New Zealand.

2. In the young carpophore, the fundament of the hymenophore first appears, followed by the demarcation of the margin of the pileus and the appearance of a gill cavity.

3. The development of the "peridium" is like that of the cap of *Agaricus campestris*, showing a primitive *velum universale* and a pileus. No true *velum partiale* is found, though a layer of "neutral tissue" occurs which may represent it. The universal veil disappears during the maturation of the plant.

4. The hymenophore consists of radiating, branched, and anastomosing gills decurrent at the top of the columella.

5. The trama and hymenium are simple in structure, without pseudoparenchyma or cystidia.

6. The young basidium has two nuclei, which unite to form one. This latter divides twice to form four nuclei for the four spores. The mycelial cells are binucleate.

7. *Secotium agaricoides* is nearly related to *Agaricus* (*Psalliota*), being an arrested or paedogenic form. It is not closely related to the Gasteromycetes or Phalloids.

The author is indebted to the Botanical Department of the State

University of Iowa for a loan of high power lenses, and to the management of the Missouri Botanical Garden for the use of books. These favors are gratefully acknowledged.

GRINNELL, IOWA.

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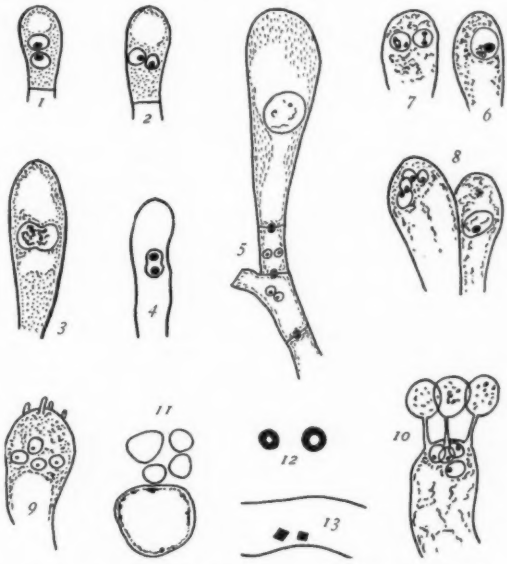


FIG. 1. 1, 2, young binucleate basidia. 3, 4, fusion of nuclei in young basidium. 5, uninucleate basidium, with cells of subhymenium. 6, fusion-nucleus of basidium, probably in synapsis. 7, two nuclei resulting from division of fusion-nucleus. 8, basidium on right with fusion-nucleus; on left 4-nucleate stage. 9, budding out of sterigmata. 10, formation of basidiospores. 11, central hyphae of rhizomorph in cross section; two sizes with intercellular spaces. 12, thick walled hyphae from surface of rhizomorph. 13, protein crystals in large hyphae of rhizomorph. All drawings made with camera lucida; 1, 2, 3, 4, 5, 11, 12, 13 with $\frac{1}{6}$ in. objective; 6, 7, 8, 9, 10, with $\frac{1}{12}$ in. objective.

DESCRIPTION OF PLATE CLVII

Photomicrographs by Paul H. Smith

Fig. 1. Median longitudinal section of specimen 3.5 mm. in diameter. First indications of pileus and hymenophore.

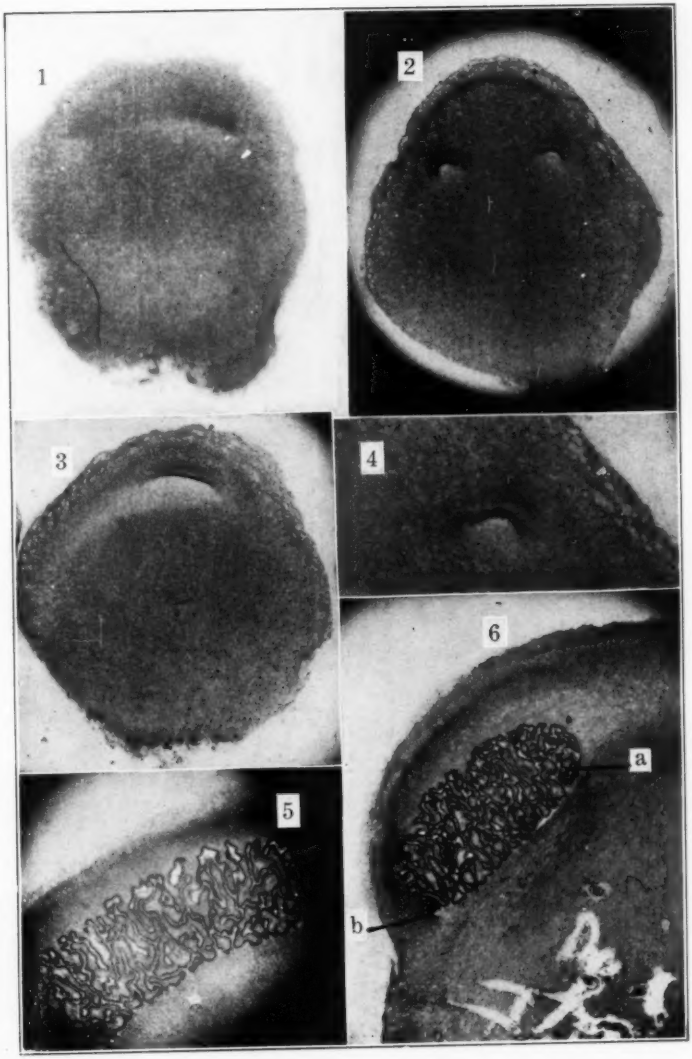
Fig. 2. Median longitudinal section of 3.8 mm. specimen. Fundament of hymenophore and gill chamber.

Fig. 3. Tangential section of same specimen.

Fig. 4. Portion of Fig. 2, enlarged.

Fig. 5. Transverse section of 9 mm. specimen.

Fig. 6. Median longitudinal section of 9 mm. specimen. a, decurrence of gills; b, marginal growth of gills.



SECOTIUM AGARICOIDES (CZERN.) HOLLÓS

THE GENUS LEPISTA

WILLIAM A. MURRILL

This genus, which is closely related to *Entoloma*, was founded by W. G. Smith in 1870, with *Paxillus Lepista* Fries as its type. Gillet included in it only those species having very decurrent lamellae, which were related rather to *Paxillus* than *Tricholoma*. Maire, in 1913, erected the genus *Rhodopaxillus*, to include *Tricholoma panaeolum*, *T. nudum*, *T. personatum*, and a few other related species.

LEPISTA (Fries) W. G. Sm. Clavis Agar. 26. 1870

Hymenophore large, fleshy, putrescent; surface smooth, not viscid, margin at first involute; lamellae adnexed or slightly decurrent; spores rosy-ochraceous in mass, not angular; stipe central, fleshy; veil none.

Type species, *Paxillus Lepista* Fries.

Spores 7–10 × 4–5 μ.
  Stipe 15–30 mm. thick. 1. *L. personata.*
  Stipe 4–8 mm. thick. 2. *L. domestica.*
Spores 5–6 × 3–4 μ; species very rare. 3. *L. panaeola.*

1. LEPISTA PERSONATA (Fries) W. G. Sm. Clavis Agar. 37. 1870

?Agaricus nudus Bull. Herb. Fr. *pl. 439.* 1789.

Agaricus violaceus Sow. Engl. Fung. *pl. 200.* 1799. Not *Agaricus violaceus* Schaeff. 1774.

Agaricus bicolor Pers. Syn. Fung. 281. 1801. Not *Agaricus bicolor* Batsch. 1783.

Agaricus personatus Fries, Obs. Myc. **2**: 89. 1818.

Tricholoma personatum Quél. Champ. Jura Vosg. 45. 1872.

Rhodopaxillus personatus Maire, Ann. Myc. **11**: 338. 1913.

Pileus compact, becoming soft, thick, convex or plane, obtuse, regular, solitary or gregarious, 5–12 cm. broad; surface moist, glabrous, variable in color, generally pallid or cinereous tinged with violet or lilac, sometimes wholly violet, margin at first involute and villose-pruinose, becoming glabrous; context whitish, pleasant to the taste, edible; lamellae broad, crowded, rounded behind,

free, violaceous, becoming sordid-whitish or fuscous; spores ellipsoid, smooth, sordid-white, dull-pinkish in mass, 7.5–10 × 4–5 μ; stipe generally thick, often bulbous, solid, fibrillose or villose-pruinose, whitish or concolorous, 3–7 cm. long, 1.5–3 cm. thick.

TYPE LOCALITY: Europe.

HABITAT: In open woods or among long grass in fields.

DISTRIBUTION: Temperate North America; also in Europe.

ILLUSTRATIONS: Ann. Rep. N. Y. State Mus. **48**: *pl. 22;* Hussey, Ill. Brit. Myc. **2**: *pl. 40;* N. Marshall, Mushr. Book *pl. 16;* Mycologia **2**: *pl. 19, f. 1;* Sow. Engl. Fungi *pl. 209.*

EXSICCATI: Sydow, Myc. Mar. *3403, 2305;* Thüm. Fungi Austr. *1001;* Herpell, Präp. Hutpilze *63.*

2. **Lepista domestica** Murrill, nom. nov.

Agaricus sordidus Fries, Syst. Myc. **1**: 51. 1821. Not *Agaricus sordidus* Dicks. 1785.

Tricholoma sordidum Quél. Champ. Jura Vosg. 47. 1872.

Rhodopaxillus sordidus Maire, Ann. Myc. **11**: 338. 1913.

Melanoleuca sordida Murrill, Mycologia **6**: 3. 1914.

Pileus thin, convex to plane or slightly depressed, subumbonate at times, often irregular, gregarious or cespitose, 3–7 cm. broad; surface smooth, glabrous, pale-violet to avellaneous with ochraceous hues, usually fuliginous on the disk, margin naked, involute when young; context violaceous to whitish, mild, edible; lamellae sinuate to slightly decurrent, narrow, crowded, concolorous when young, fading with age; spores ellipsoid, smooth, pale-rosy-ochraceous in mass, 7–8 × 4–5 μ; stipe eccentric at times, equal, firm, concolorous, glabrous, stuffed or hollow, 3–8 cm. long, 4–8 mm. thick.

TYPE LOCALITY: Europe.

HABITAT: About manure piles and in manured ground.

DISTRIBUTION: Temperate North America; also in Europe.

ILLUSTRATIONS: Bull. N. Y. State Mus. 116: *pl. 104;* Bull. N. Y. State Mus. 131: *pl. 115;* Cooke, Brit. Fungi *pl. 100 (125);* Fries, Ic. Hymen. *pl. 15;* Mycologia **6**: *pl. 113, f. 4.*

3. LEPISTA PANAEOLA (Fries) P. Karst. Bidr. Finl. Nat. Folk 481. 1879.

Agaricus panaeolus Fries, Epicr. Myc. 49. 1838.

Agaricus ectypus Secr. Mycogr. Suisse **2**: 86. 1833. Not *Agaricus ectypus* Fries, 1821.

Tricholoma panaeolum Quél. Champ. Jura Vosg. 45. 1872.
Gyrophila nimbata Quél. Fl. Myc. Fr. 271. 1888.
Rhodopaxillus panaeolus Maire, Ann. Myc. **11**: 338. 1913.

Pileus fleshy, convex to expanded, gibbous, sometimes eccentric, cespitose, 4–9 cm. broad; surface whitish-gray, grayish-variegated and dull-flesh-colored when young; context gray, odor strong, farinaceous-rancid, taste mild; lamellae mostly crowded, sometimes narrow and sometimes broad, easily separable from the hymenophore, sinuate-uncinate, sometimes decurrent, from whitish-gray to lurid-flesh-colored or rufescent; spores ellipsoid, slightly tuberculose, hyaline, dull-rosy in mass, 5.5–6 × 3.5 μ; stipe solid, gray to grayish-fuscous within, subequal, fibrillose, subfurfuraceous at the apex, 2–6 cm. long, 5–13 mm. thick.

TYPE LOCALITY: Switzerland.

HABITAT: In grassy places in the open or near woods; rarely in woods.

DISTRIBUTION: New York; also in Europe.

ILLUSTRATION: Fries, Ic. Hymen. *pl. 36, f. 2.*

NEW YORK BOTANICAL GARDEN.

MARKING TYPES IN THE MYCOLOGICAL HERBARIUM

WILLIAM A. MURRILL

An article by Swingle on the designation of types appeared in *Science,* June 6, 1913, in which the discussion was confined to flowering plants. Dr. Swingle's statement that a type has no duplicate would hardly be appropriate when applied to fungi, since several sporophores usually arise from the same mycelium and the type collection may include one or more of these sporophores. For this reason, I would suggest the term extype instead of clastotype for a part of the type, since a part of the type is not necessarily a fragment. The term cotype should be omitted altogether, to avoid confusion. The principal terms to be used would then be: *type collection, type* (including *lectotype*), *extype* (including *clastotype*), *microtype* (suggested for a part of the type mounted for microscopic study), and *paratype* (including *syntype*).

Rubber stamps bearing the words "Type Coll.," "Type," "Extype," "Microtype," and "Paratype" may be used in the mycological herbarium with great advantage.

It frequently happens that a collector is unable to distinguish closely related plants and places two or more species under one field number. In such cases, the actual specimens used by the publisher of the species would be the type and it would be unsafe to designate as such any other portion of this same collection.

Certain questions will always arise which will be settled differently by different persons. For example, if a portion of a collection is sent away to a specialist and he makes it the type of a new species, the remaining portion may not always receive the same designation. In the case of mosses, it is quite necessary that the one who publishes the species should see all the material in order to be sure that it is the same thing. This may be true in various other groups also.

NEW YORK BOTANICAL GARDEN.

NEWS AND NOTES

Professor J. C. Arthur and Dr. F. D. Fromme, of Purdue University, Lafayette, Indiana, spent the month of January at the Garden in continuation of their studies of the Uredineae for *North American Flora*.

Mr. C. A. Schwarze spent most of January and February at the Garden examining and making illustrations from herbarium material relating to the parasitic fungi of New Jersey.

According to J. H. Faull and G. H. Graham, the chestnut canker has been found at Agassiz, British Columbia, on trees of Oriental, European, and American origin.

Dr. Charles E. Bessey, Professor of Botany at the University of Nebraska for over thirty years, died at Lincoln on February 25. He was born at Milton, Ohio, May 21, 1845.

Dr. A. G. Johnson, of the University of Wisconsin, recently visited the Garden to examine the collections of *Helminthosporium* in the mycological herbarium.

The chestnut canker was collected twice in Nebraska during last September and October by R. G. Pierce. The chestnut is not native in Nebraska, but it is beginning to be planted in some parts of the state and the disease was introduced with Paragon nursery stock from Pennsylvania.

Miss Caroline Rumbold, in *Phytopathology* for February, gives a brief account of successful experiments in infecting chestnut

burrs and nuts with the chestnut canker. Nuts infected with the canker become soft and crumbly and are extremely bitter to the taste. There is no doubt that the disease may very easily be spread by means of these infected fruits.

Dr. George G. Hedgcock, of the Bureau of Plant Industry, spent the first two weeks in February at the Garden examining specimens of various tree-destroying fungi. He brought a very large and valuable collection with him for comparison and was able to spare portions of many of the specimens for the Garden herbarium.

"Southern Polypores," by W. A. Murrill, appeared January 30, 1915. New combinations used in this work are: *Inonotus ludovicianus* (Pat.) Murrill, *Elfvingiella fasciata* (Sw.) Murrill, and *Spongipellis fragilis* (Fries) Murrill. "American Boletes" and "Northern Polypores," by the same author, were issued December 8, 1914. In the latter work, two new genera, *Fulvifomes* and *Elfvingiella,* were published, with several new combinations.

In the *Annals of the Missouri Botanical Garden* for September and November, 1914, Professor E. A. Burt continues his treatment of the Thelephoraceae of North America, devoting one paper to *Craterellus* and one to *Craterellus borealis* and *Cyphella.* His key to *Craterellus* includes 17 species, 5 of which are described as new and 1 newly combined. Twenty-one species are included under the genus *Cyphella,* 5 of which are new. Both papers are well illustrated.

A bulletin on practical tree surgery, by J. F. Collins, recently published by the Division of Forest Pathology at Washington, contains very careful directions for treating the trunks of trees that have suffered from wounds or diseases. The author states that the science of tree surgery has suffered from dishonest and uneducated men engaged in this work, and he predicts that very

superior methods will be discovered and put into practice in the near future. The most valuable paragraph in the bulletin reads as follows: "Finally, tree owners are urged to remember at all times the axiom: The need of tree surgery 15 or 20 years hence may be very largely obviated by promptly attending to the fresh injuries of to-day."

Some observations on abortive sporophores of wood-destroying fungi were reported by James R. Weir in *Phytopathology* for February, 1915. He comes to the conclusion that the peculiar abnormal growths on birch trunks are without doubt sterile sporophores of *Pyropolyporus igniarius*. He has found similar abortive sporophores of this species on alder trunks in Montana, and sterile ram's-horn-like sporophores of *Porodaedalea Pini* on the western white pine. An interesting statement made by Mr. Weir in this article is to the effect that the mycelium of one species attacking a tree trunk is always antagonistic to that of another species on the same trunk, and, since the mycelium of typical *Pyropolyporus igniarius* is not antagonistic to that of its principal variety, *P. igniarius nigricans*, the latter cannot be looked upon as a distinct species.

CHARLES HORTON PECK RETIRES

The following minute has been adopted by the regents of the University of the State of New York on the retirement of Dr. Charles H. Peck from the position of state botanist:

The service rendered to the state by Charles Horton Peck, D.Sc., who has just retired from his position as state botanist, has been extraordinary in its fidelity, assiduity and productiveness. Dr. Peck entered the staff of the State Museum as botanist in 1867, and from that date to the present, his service has been continuous—a period of 48 years. In 1883 the position of state botanist was created and he has been its only incumbent.

The nearly half century of his scientific activity became an epoch in the science of botany in America, by virtue of the extensive contributions which he made, not alone to the knowledge of the flora of New York but specially through his almost pioneer investigations among the fungi. His researches in this field vastly increased the sum of knowledge and established an orderly and rational classification so that his published papers, issued in the reports of the state museum, are indispensable to any student of these forms of life.

The number of species discovered and described by him are counted by thousands and the additions made through his efforts to the state herbarium are so extensive that this collection of plants is to-day among the largest on the continent and of great scientific worth. By common consent of his colleagues Dr. Peck has long been recognized as the ultimate authority in mycology—the field of his special labors.

In view of these services whose value to the state can not be briefly estimated or readily expressed, the regents take this occasion to record, with their regret that the exactions of time have impelled him to retire from the service of the university and the state, their congratulations to Dr. Peck upon a life well rounded and a work well done, with their assurance of continued interest and deep regard for his welfare during the years that may remain.

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